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EDITED BY

EDWIN LANKESTER, M.D., F.R.S., F.L.S.,

AND

GEORGE BUSK, F.R.C.S.E., F.R.S., F.L.S.,

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TRANSACTIONS.

On a species of Filamentous Diatom *new to* Britain.

By Arthur S. Donkin, M.D., Morpeth.

(Read June 10th, 1857.)

In the 'Quarterly Journal of Microscopical Science,' vol. iv, p. 105, Mr. Brightwell, in a communication on the filamentous long-horned Diatomaceæ, describes two species of these singular Algæ as the first which have been, in a living state, discovered in this country: these are *Chætoceros Wighamii,* gathered by Mr. Wigham, at Breydon, near Yarmouth, in July, 1854; and *Goniothecium hispidum,* since found with the preceding, in the bay of the Isle of Roa, near Ulverstone. Since the date of Mr. Brightwell's communication, no other native member of the family has, I believe, been discovered.

Within the last few days, however, it has fallen to my lot to discover a third species in a recent condition, which, if I am not mistaken, has hitherto been found only in a fossil state in certain diatomaceous earths, and in the guano deposit on the coast of Peru; from which it appears to possess a very wide geographical range. This species is the *Syndendrium diadema* of Ehrenberg, easily recognised by the peculiar form of its frustule, with its numerous styles having branched extremities proceeding from its larger or more convex surface. This species was discovered in the following manner. A few days ago, I purchased a lobster taken off the Cresswell coast, nine miles to the east of Morpeth, not far from low-water mark, where the sea bottom is covered with flat rocks and the larger Algæ luxuriant. After subjecting the contents of this lobster's stomach to the action of boiling nitric acid for several minutes in a small retort, and after removing the acid from the remaining sediment by repeated ablutions with distilled water, I was not a little astonished to discover on all the slides—on which a portion of this sediment was placed—several specimens of *Syndendrium diadema;* its frustules being more numerous than those of any other diatom. From this fact it would appear, that this remarkable form is quite common on this part of the Northumbrian coast (but this I mean shortly to ascer-

tain by future investigation); and if so, which I little doubt, it will materially assist, by the facility offered for the study of its living form and economy, in solving the question as to whether the group, to which it belongs, ought to be classed amongst the Diatomaceæ, from which it has been excluded by Professor Smith in his recent 'Synopsis,' and by others, as of a doubtful character. It will also assist in determining whether those various species of the same family, hitherto observed only in a fossil or semi-fossil condition, have in the living state their frustules aggregated into filaments, or whether these exist as separate and independent organisms.

That the different genera constituting the filamentous Algæ will, by future investigation, be ultimately classed amongst the diatoms, although perhaps as an aberrant sub-family, I am inclined to believe. They possess one essential characteristic of the Diatomaceæ, namely, an external siliceous envelope, rendering their minute forms indestructible, either by the lapse of time or by the action of decomposing agents, ordinary or extraordinary, by which all other organized structures are resolved into their ultimate elements. But future observation must determine their relative position to their congeners by a careful study of their mode of development, and of the reproduction of their species.

On the MARINE DIATOMACEÆ *of* NORTHUMBERLAND, *with a Description of* EIGHTEEN NEW SPECIES. By ARTHUR S. DONKIN, M.D. Morpeth, Northumberland.

(Read October 21st, 1857.)

HAVING in the course of the past summer had occasion to visit the shores of this county for relaxation and pleasure, I embraced the opportunity thus thrown in my way of examining to some extent her marine *Diatomaceous products*; a work for which I was in some measure prepared, by having for the last few years devoted a portion of my leisure time to this particular field of inquiry, more especially in studying the fresh-water species.

I must own, too, that I was in no small degree prompted to the undertaking by knowing that the Northumbrian waters, have hitherto been, to the microscopist, unexplored regions. For, however carefully certain branches of her

natural history have been studied by the labours of her native naturalists—her ornithology by the immortal Bewick, and, more recently, by the accomplished Mr. Selby—her zoophytology by the late Dr. Johnston, and by Messrs. Alder and Hancock—no one yet had thought it worth his while to explore her springs, streams, lakes, subalpine tarns, and the waters of her extensive sea-board, in search of those microscopic beings, the Diatomaceæ; beings on whose surfaces, invisibly minute to the unaided vision of man, the omniscient hand of Creative Wisdom has found sufficient space to carve designs, so varied and elaborately beautiful, that their investigation has become a pleasurable pursuit even to some of the most philosophic spirits of the present age.

After some considerable investigation carried on amongst the fresh-water *forms,* which everywhere in this county abound, I became convinced of the accuracy of Professor Gregory's remark,* to the effect, that those in search of new species belonging to this already extensive group, must procure his materials from the boundless waters of the ocean. This accurate suggestion I have followed, and have now to lay the result of my labours before this society. But before entering *in medias res,* a few brief remarks on the physical characters of this coast, and the manner in which I procured the objects of my research, may be novel and interesting to some of our members.

The Northumbrian shore, extending from the Tyne to the Tweed, embraces a coast line of about seventy miles, washed by the waters of the German Ocean; it presents, in this wide range, attractions of the highest order to the tourist, the archeologist, and the naturalist. Here are the Farn Islands, the favourite resort of sea-fowl, and the scene of the heroic feat of Grace Darling. The Saxon monastery of St. Cuthbert, at *Lindisfarne,* fills the mind with poetical associations:

> " A solemn, huge, and dark-red pile,
> Placed on the margin of the isle;
> . . . . . .
> Which could twelve hundred years withstand
> Wind, waves, and northern pirates' hand."

Here, too, are the lofty towers of Bambrough—

> "King Ida's castle, huge and square,—"

and the baronial castles of Dunstanborough and Warkworth, pointing, amidst their dismantled solitude, to bygone times

* 'Trans. Micr. Soc.,' vol. v, p. 86.

of feudalism, when the pursuits of war and rapine left science no votaries.

The natural features of this district are not less varied than its historical records are attractive. Here are rude precipitous promontories, some of sandstone, others of massive basaltic columns, rearing their heads majestically above the storm, and bidding bold defiance to the onward sweep of the incessant surge, which, in its futile efforts to upheave these cyclopean monsters from their primeval birthplace, is scattered back in clouds of white and sparkling spray, forming a picture sufficiently fascinating even to the most apathetic of nature's admirers. In such situations as these, flat reef-shaped rocks of sandstone, covered with a luxuriant growth of the larger Algæ, stretch far beneath the waves; at ebb tide these are laid bare for a considerable distance, and abound in *grallatorial* bipeds, and in all that would grace an aquarium. Beyond these "points" again, the eye rests on calm, sleepy bays, surrounded by a sandy beach, and by sand hills, the creation of the winds, and which the matting *sea-reed* (*Psamma arenaria*) prevents from being dissipated by the same element. Here also are the estuaries and mouths of several rivers discharging their waters into the ocean, and forming harbours for the extensive prosecution of the coal trade.

That a shore such as I have described should abound in diatoms might readily be supposed. The method I pursued in procuring these I shall now pass on to describe; I have found it superior to any other for obtaining marine forms. Professor Smith states,* that "the shallow pools left by the retiring tide at the mouths of our larger rivers" are the favourite habitat of marine species. But such localities I have found not to be half so prolific in species as the *sands of still bays, on the shore, where they are exposed by the reflux of the tide, at a distance corresponding with the half-tide margin.* In these places, where the sands are sloping towards the sea, and grooved out into small furrows, filled with salt water oozing out from behind, the abundance of diatoms aggregated into a living mass, imparts to the surface of the sand different hues of chestnut and olive; the difference of colour being due to the nature of the species present. These coloured patches, it is interesting to observe, are, during the sunshine, studded with numerous minute air-bubbles, undoubtedly given off by the diatoms themselves.

To separate the diatoms thus detected from the surface

* 'Synops.,' vol. i, Introd., p. i.

of the sand I found to be impossible. I therefore seized hold of the nearest bivalve shell which happened to lie in the way, and with this I carefully scooped up the surface of the coloured sand. This I emptied into a wide-mouthed, stoppered bottle, capable of holding eight ounces, until half full; the other half of the bottle I filled up with salt water. I then shook the whole briskly and allowed the bottle to stand for a short period. The sand, being composed entirely of fine round grains of quartz and the minute fragments of shells, settled at the bottom in a few seconds, leaving the diatoms all suspended in the water above, and forming by their abundance a chestnut-coloured cloud, but not more than 1 part in 1000 of the whole sand collected. The coloured water was then poured into another bottle and formed the gathering, while the sand was thrown away. The diatoms, in their turn, were separated from the superfluous water by subsidence, and brought home in $1\frac{1}{2}$oz. bottles. In this manner I soon found that any quantity could be collected in a pure and unmixed condition, affording an excellent opportunity of examining their living forms, and one of which I availed myself on every occasion.

After carefully examining materials collected in this way from various parts of the beach, I detected not less than about 100 species, all these strictly marine, and, with a few exceptions, each species in considerable abundance. But I was not a little surprised to find that out of this large number it was utterly impossible to refer more than forty-eight of these to Professor Smith's 'Synopsis.' I found, too, that I had gathered eighteen of the new forms discovered by Professor Gregory in the estuary of the Clyde, and described in his various papers on the Glenshira Sand, and in his more recent and very valuable contribution on the Marine Diatomaceous Forms of the Clyde.* The remaining species, above thirty in number, are entirely new and undescribed, many of them of great interest and beauty. As, however, a description of the whole of these would extend the present communication to an undue length, I shall, on this occasion, confine myself to a few, and take an early opportunity to describe the remainder, together with my future investigations on this shore, in a separate paper.

In recording all the marine species found on the Northumbrian shore, I shall arrange them under the following heads for the sake of reference: I. *Species described in Professor Smith's 'Synopsis.'* II. *Species described by Professor Gregory*

* 'Trans. Royal Soc. Edinb., vol. xxi, part iv.

as new, or new to Britain, in his various papers. III. *Species entirely new, and for the first time described in the present paper.*

I. *Species described in Professor Smith's 'Synopsis.'*

Amphora affinis.
,, salina.
Tryblionella punctata.
,, acuminata.
Cocconeis scutellum.
,, diaphana.
Eupodiscus Ralfsii, β sparsus.
Actinocyclus undulatus.
Coscinodiscus radiatus.
Nitzschia spathula.
,, reversa.
,, closterium.
Synedra superba.
,, tabulata.
Navicula pygmala, β minutula.
,, palpebralis.
,, Smithii.
,, punctulata.
,, Jenneri.
,, humerosa.
,, didyma.
,, crabro.
,, lyra.
Pinnularia distans.
Pinnularia directa.
Stauroneis pulchella.
Pleurosigma formosum.
,, elongatum.
,, prolongatum.
,, strigosum.
,, quadratum.
,, angulatum.
,, æstuarii.
,, balticum.
,, hippocampus.
Amphiprora vitrea.
Biddulphia Baileyii.
,, aurita.
Gomphonema marinum.
Achananthes brevipes.
,, subsessilis.
Rhabdonema arcuatum.
,, minutum.
Grammatophora marina.
,, serpentina.
Melosira nummuloides.
Orthosira marina.
Isthmia enervis.

The stipitate forms enumerated above, I need not say, were not gathered in their natural habitat on the sands; but the frequent occurrence of their frustules, in such a locality, was a sufficient indication of their abundance on the larger Algæ, with which the neighbouring rocks of the shore are covered.

The beautiful and curious *Biddulphia Baileyii* was plentiful in several of the gatherings; it seems to me to be a free species; I have observed its frustules undergoing the process of self-division.

Navicula Smithii is here a plentiful species; *N. Lyra* is also very common in all its varieties; *N. crabro* frequent; and *N. humerosa* occurs abundantly in some localities; it is a species variable in its outline, but very uniform in its striation; its *dry valve is colourless,* thus differing widely from *N. granulata,* Bréb.

II. *Species new, or new to Britain; first discovered by Professor Gregory in the estuary of the Clyde.**

Campylodiscus simulans, Greg. ('Trans. Micr. Soc.,' vol. v, Pl. I, fig. 41).—This species occurs in Druridge Bay, but is somewhat scarce; it appears to me to be a genuine *Campylodiscus.* The valves, in all the specimens in my gathering, are orbicular and saddle-shaped; the *median* or *central space* is oval, with truncate extremities reaching nearly to the margin; it is marked transversely with parallel lines from side to side, and its *long axis in one valve* is at *right angles to that of the same space of the opposite;* the centre of the entire frustule thus presents a finely *fenestrated* appearance when in a certain focus, owing to the crossing at right angles of the transverse lines of the two opposed spaces. In these respects it differs widely from *Surirella fastuosa* and *lata,* of which Professor Gregory thinks it may be a variety.

Coscinodiscus concavus, Ehr. (Greg., 'Clyde Forms,' pl. ii, fig. 47).

Frequent along the coast.

Navicula granulata, Bréb.—The form of this species varies widely, from being in some specimens nearly orbicular to linear, or linear constricted in others; the extremities being always obtuse and produced. The striæ are coarse and widely punctate, *but always uniform.* It cannot be confounded with *N. humerosa,* Bréb. (*quadrata,* Greg., 'Trans. Micr. Soc.,' vol. iv, Pl. V, fig. 5), which also varies much in outline, by the most careless observer. As both forms were abundant in some of my gatherings, I have had an opportunity of comparing hundreds of specimens.†

Hab. Cresswell and Linemouth, abundant.

Navicula latissima, Greg. ('Trans. Micr. Soc.,' vol. iv, Pl. V, fig. 4).

Frequent at Linemouth.

* I have satisfied myself that all the species enumerated under this head occur on the Northumbrian shore, having carefully compared specimens with those contained in series of slides, kindly sent to me by Professor Gregory, illustrative of all his new Clyde forms.

I may also mention that, independent of these, I have detected several other species found in the Clyde, of which Professor Gregory intends shortly to publish a description. I have therefore not alluded to these in this paper.

† I have thought proper to give two figures of this large and beautiful species (fig. 19, *a* and *b*), to show how much it varies in its outline. The dry valve, when seen with a low power, is of a dull bluish colour, inclining to purple; while that of *N. humerosa* is colourless and hyaline.

Navicula clavata, Greg. ('Trans. Micr. Soc.,' vol. iv, Pl. V, fig. 17).

Frequent at Chibburn Mouth, Druridge Bay, and very large.

Navicula maxima, Greg. ('Cly. For.,' pl. i, fig. 18).

Frequent at Cresswell.

Navicula angulosa, Greg. ('Trans. Micr. Soc.,' vol. iv, Pl. V, fig. 8).

At Linemouth plentiful.

This species is very easily recognised from *N. Barclayana,* Greg. I did not find a single frustule of it in the gathering from Cresswell, in which the latter form was most abundant.

Navicula Barclayana, Greg. ('Cly. For.,' pl. i, fig. 9).

Frequent in many localities; at Creswell abundant. Easily recognised from *N. palpebralis,* Bréb.

Amphiprora maxima, Greg. ('Cly. For.,' pl. iv, fig. 61).

Frequent; at Cresswell plentiful.

Apr. pusilla, Greg. ('Cly. For.,' pl. iv, fig. 56).

Frequent; at Cresswell plentiful.

Apr. lepidoptera, Greg. ('Cly. For.,' pl. iv, fig. 59).

Frequent near Newbiggin.

Amphora Grevilliana, Greg. ('Cly. For.,' pl. v, figs. 89 and 90).

This beautiful and strongly marked species is abundant at Cresswell and frequent at Linemouth.

A. cymbifera, Greg. ('Cly. For.,' pl. vi, fig. 97).

Plentiful at Linemouth.

A. lævis, Greg. ('Cly. For.,' pl. iv, fig. 74 *c*).

This species is abundant near Newbiggin. In Druridge Bay I have found frustules identical with that of fig. 74 *d*, which Professor Gregory now considers to be a distinct species, and not a variety of *A. lævis.*

A. lævissima, Greg. ('Cly. For.,' pl. iv, fig. 72).

At Newbiggin very abundant.

A. robusta, Greg. ('Cly. For.,' pl. iv, fig. 79).

This interesting and well-marked species is frequent at Cresswell.

Cocconeis distans, Greg. ('Cly. For.,' pl. i, fig. 23).

Near Newbiggen frequent.

III. *New Species.*

The first two species which I have to describe as new are forms so remarkable, and so different in certain structural peculiarities from every member of any of the genera hitherto

discovered, that it becomes essentially necessary to establish an entirely new genus to which to refer then. This genus (to be characterised by the curve of the median line, and by the structure of the valve) I have termed *Toxonidea* (τοξον and ιδεα, bow-shaped).

TOXONIDEA.

Frustules free; valves elongated, convex, *with two sides not symmetrical;* striated, striæ oblique. Median or longitudinal line *arcuate,* with central and terminal nodules, *the latter curving towards the same side of the valve.*

One distinguishing feature, then, of this new genus, in addition to the *arcuate median line,* being the *oblique striation of the valve* (probably due to cellular structure), found so well developed in one section of the genus *Pleurosigma,* it is evident that it bears a close natural affinity to this latter group, and that both are members of the same sub-family. That the *arcuate curve* of the median line, together with the want of symmetry observable in the opposite margins of the valve, which indeed is strongly *arcuate* on one side, in one of the forms, and slightly so in the other, to say nothing of the total absence of any sigmoid tendency, is a structural difference sufficient to warrant the separation of these two species in question from the genus *Pleurosigma,* is apparent from the fact, that to admit them into it would be equivalent to abolishing the most distinctive character on which that group has been founded by Professor Smith, who observes that "the sigmoid flexure of the valve, more or less present in all our native species, at once distinguishes this genus from its allies."

1. *Tox. Gregoriana,** n. sp.—Valve straw-coloured, lanceolate; extremities obtuse, and curved strongly towards one side of the valve. Median line, on each side of the central nodule, curved first towards one side of the valve, then, some distance from the extremities, gradually and more strongly towards the opposite, until it reaches the terminal nodules; when viewed from one extremity to the other it has a most graceful appearance, resembling a representation of an unbent *Scythian bow.* Length from 0·008″ to 0·009″; breadth from 0·001″ to 0·0016″. Striæ oblique, fine, probably 50 in 0·001″.†

* I have dedicated this species to Professor Gregory, my former and highly esteemed teacher, by whom our knowledge of British marine Diatomaceæ has been considerably enlarged.

† I may here state that, in describing the *striæ* of this, as well as of the following seven species, I have merely attempted to *guess* the number of

I have already remarked that want of symmetry in the opposite margins of the valve is a well-developed character of the genus *Toxonidea*. This is well illustrated in the present species, and is more easily understood by examining the valve itself (fig. 1, Pl. III), which presents an appearance different from that of any other known diatom. One margin, which, as in the next form to be described, I shall term the *dorsal*, follows very closely the curve of the median line, and is gently arcuate through the greater portion of its extent; but near to the extremities of the valve it curves gradually backwards in the opposite direction. The ventral margin, on the other hand, bears no relation to the median line; it is almost linear, but slightly convex until near the extremities, where, after approaching close to the median line, it curves strongly backwards to its junction with the dorsal margin. The ventral margin then is linear elliptical. The striation appears to be as fine as that of *Pl. angulatum*, and the *areolation* of the *Pleurosigmata*, with a sufficient power and illumination, is very distinct.* The striæ, however, are much more easily resolved as *transverse* than as oblique; owing, doubtless, to some structural peculiarity of the valve not found in the *Pleurosigmata*.† When viewed with a good $\frac{1}{5}$ objective, and very oblique light from the mirror, the striæ always appear transverse, like a finely marked *Stauroneis*, unless the light fall upon it at a particular angle, when they come out distinctly in an oblique manner.

these in 0·001″, by taking *Pl. angulatum* as a standard, by which I visually compared them. It is therefore probable that I may be, in some instances, a little wide of the truth. If so, the error was unavoidable, as the highest power I possess is a superior one-fifth objective; with this it is quite impossible to count lines so fine as those with which the forms in question are marked. But this is a deficiency of little practical utility, as the microscopist must learn to measure the *marking* of minute objects by the eye rather than by the micrometer.

* With one of Smith and Beck's instruments, their one-fifth objective of 100° aperture, No. 1 eye-piece, five inches of the draw-tube, and the illumination afforded by their achromatic condenser, having the central portion of the illuminating pencil cut off by a central stop, the areolation becomes very distinct; but much more so with No. 2 eye-piece and the same length of draw-tube, giving a power of 655 diameters.

† On discovering this species, on the 28th of June last, I sent a specimen to Mr. Shadbolt, as a very remarkable *Pleurosigma*, which I termed *Pl. arcuatum*, not having then detected the smaller form which led to the formation of the present genus. After examining it carefully, he wrote to me as follows: "Your *Pl. arcuatum* is undoubtedly new, but I have some doubts about the *genus;* the aspect and general appearance is very like a *Pleurosigma;* but under a low power it looks like a *Stauroneis*, owing to a peculiarity in the internal part of the frustule. The areolation is very distinct, and is exhibited with a one fifth without difficulty when properly illuminated."

This splendid species I found plentiful in gatherings from Cresswell and Linemouth. In a gathering from Newbiggin, in which the next form abounded, I could not detect a single frustule. It occurs on several other parts of the coast.

2. *Tox. insignis,* n. sp.—Valve straw-coloured; dorsal margin strongly arcuate, ventral linear; extremities sub-acute, on dorsal margin produced. F. V. linear lanceolate, only seen in the living frustule. Median line not central, strongly arcuate near the centre. Length from 0·0048″ to 0·006″; breadth of S. V. about 0·001″. Striæ very fine, probably from 75 to 80 in 0·001″.

This very remarkable form in its outline, in short specimens especially, very much resembles a strung bow or a "cocked" hat. The strongly arcuate curve of the dorsal margin ceases a short distance from the extremities of the valve; the margin then pursues an almost linear course to its termination, thus giving the extremities on this side a produced appearance. The almost linear ventral margin at each extremity curves gently backwards. The median line is most gracefully arcuate; it curves strongly towards the ventral margin, and after nearly approaching it, continues an almost rectilinear course, though just perceptibly backwards to the terminal nodules, which are strongly curved to the dorsal side. The median line is far from central, being situated no great distance from the ventral margin.

The striæ are remarkably fine and most difficult to exhibit, and, as in the preceding species, come out transversely much more easily than as obliquely. The areolation I have observed with a $\frac{1}{5}$, but with this power it is very faintly seen, even with the most favorable illumination and careful manipulation. The valve is undoubtedly a far more difficult test object for a $\frac{1}{4}$ or a $\frac{1}{5}$ objective than any of the *Pleurosigmata* at present employed for that purpose, with the exception of *Pl. fasciola* and *Pl. obscurum,* which, however require the aid of a superior $\frac{1}{8}$ or $\frac{1}{12}$ for the full exhibition of the striæ, owing to their *faintness.*

I have frequently examined the living frustule of this species; it moves through the water with the S. V. uppermost, occasionally turning on its dorsal surface for a few seconds, thus exhibiting a good view of the F. V.

Hab. Frequent at Cresswell, and near Newbiggin abundant.

PLEUROSIGMA.

Ooservations made on some of the species of this genus, about to be described, have convinced me that *sigmoid flexure*

of the valve is not so general as to render it applicable for one of the most important generic distinctions of a group so extensive as that of *Pleurosigma.* It appears to me, that *curvature of the median line, and not of the valve itself,* must be looked upon as a characteristic feature of this genus, and that all its known species prove these two important facts: First, that the median line may be sigmoid, even strongly so, without any obvious curvature of the valve; for example, *Pl. lanceolatum* and *Pl. carinatum* (figs. 4 and 5, Pl. III). Secondly, that when the valve is sigmoid, it is so in conformity with the median line, as in *Pl. hippocampus* and others; and that, although the whole valve may not observe the same amount of curve throughout as the median line, yet one margin at least, towards each extremity, generally does so.

Section I. *Striation oblique.*

3. *Pl. marinum,* n. sp.—Valve straw-coloured, lanceolate, straight, slightly sigmoid near the extremities, obtuse. Median line sigmoid on each side of the central nodule. Length 0·0055″ to 0·006″; breadth of S. V. about 0·001″. Striæ probably from 45 to 50 in 0·001″.

The well-marked sigmoid flexure of the median line, on *both* sides of the central nodule, at once distinguishes this from any other British species belonging to the present section, and renders it easy of recognition.

Hab. Newbiggin North Sands, plentiful. This is the only locality in which I have found this species.

4. *Pl. lanceolatum,* n. sp.—Valve straw-coloured, perfectly straight, broadly lanceolate, acute. Length from 0·0055″ to 0·006″; breadth from 0·001″ to 0·0014″. Median line straight, or *gently* sigmoid in the middle; terminal nodules curved in opposite directions. Striæ very fine, probably about 70 in 0·001″.

This species is remarkable in consequence of the valve being free from the slightest sigmoid flexure. In most specimens the only indication of curve exhibited by the median line is observable in the terminal nodules; in others again, in addition to this, there is a very gentle curve in opposite directions on either side of the central nodule for a short distance. The striæ are remarkably fine, and require the most careful manipulation with very oblique light to render them visible with a superior $\frac{1}{5}$ objective. The valve, therefore, is a test object of much greater delicacy than that of *Pl. angulatum,* though not equal to *Tox. insignis.**

* As corroborative of my opinion on this matter, I may adduce the tes-

Hab. Plentiful along the coast between the Coquet and the Wansbeck. Newbiggin North Sands, abundant.

5. *Pl. carinatum,* n. sp.—Valve straight, linear lanceolate, acute, very convex, colour dull purple. Length about 0·0016″; breadth about 0·0005″. Striæ fine, probably from 55 to 60 in 0·001″. Median line strongly curved on either side of the central nodule, until it approaches close to the margin of the valve, in which direction it continues to its termination; its marginal portion forming a prominent ridge or keel, which is *much more prominent on one side of the central nodule than on the other.* This peculiarity gives the F. V. an unequally keeled appearance, as seen in fig. 5 *b.*

The keeled appearance of the F. V. at first led me to suspect that the present form ought to be referred to the genus Amphiprora. But the strong sigmoid flexure of the median line, and *the distinctly oblique striation,* together with the absence of *marginal plates,** which Professor Gregory has shewn to be so generally present in the members of this genus, has convinced me that it is a genuine *Pleurosigma.* The striæ are not easily resolved in the S. V., owing to its great convexity; they however come out very distinctly in the F. V.

Hab. Newbiggin North Sands, abundant; Linemouth and Cresswell, frequent.

Section II. *Striæ longitudinal and transverse.*

6. *Pl. rectum,* n. sp.—Valve pale straw-coloured, very convex, linear, narrowest in the middle, straight, extremities rounded on one margin, somewhat obtuse. Median line strongly sigmoid; marginal for the terminal half of its extent on either side of the central nodule. Length from 0·0045″ to 0·005″; breadth about 0·0006″. Longitudinal and transverse striæ distinct, fine, probably 60 in 0·001″.

The S. V. appears sigmoid at the extremities; but it is not so. This appearance is due to one margin, on opposite sides near each extremity, following the convex curve of the median line.

Hab. Frequent. At Creswell, abundant.

timony of Mr. Shadbolt, who, after examining one of my specimens with a power much higher than I possess, sent me the following reply: "Your *Pl. lanceolatum* has markings as you indicate (oblique), which are easily resolvable under my one-twelfth, but with difficulty by the one-fifth. *They are much more difficult* than those of *Pl. angulatum.*"

* "On the Marine Diatomaceous Forms of the Clyde," 'Trans. Royal Soc. Edinb., vol. xxi, part iv, p. 32.

7. *Pl. Wansbeckii,* n. sp.—Valve pale straw-coloured, slightly convex, linear lanceolate, acute, slightly sigmoid near the extremities. Median line gently sigmoid, not central, not marginal. Length from 0·0045″ to 0·005″; breadth about 0·0006″. Longitudinal and transverse striæ probably 50 or more in 0·001″.

This species bears merely a *generic* resemblance to *Pl. angustum,* n. sp., and cannot be confounded with it. It differs widely from *Pl. rectum,* n. sp., in its much longer, acute, and gracefully sigmoid valve; in its median line, which is much less curved, and never approaches close to the margin; in its striæ, which are not so fine; and in its habitat.

Hab. Pools left by the tide, where the water is strongly brackish, at the mouth of the Wansbeck. It is not a *littoral* form. I have never met with a single specimen on the beach, where the other allied forms, described in this paper, are abundant. This fact alone, independent of structural differences, would prove it to be distinct from any of these.

8. *Pl. minutum,* n. sp.—Valve a very pale-brown colour, oblong, acute, exceedingly convex. Median line strongly sigmoid. Length about 0·0025″; breadth about 0·0005″. Striæ very fine; transverse distinct, probably 55 in 0·001″; longitudinal very obscure, owing to great convexity of the valve.

The median line in this minute species, the smallest of the genus I have seen, is not so marginal near the extremities as that of *Pl. rectum.* It differs also in its size and in the outline of the valves.

Hab. Cresswell, abundant. Frequent in some other localities.

9. *Pl. angustum,* n. sp.—Valve dull purple, rather opaque, exceedingly convex, linear; extremities acute, and slightly apiculate. Median line marginal, except in the middle, for a short space on each side of the central nodule, where it crosses the valve, forming a prominent ridge or keel. Length from 0·005″ to 0·0055″; breadth about 0·0006″, narrowest in the middle. Striæ obscure, longitudinal, visible a little on one side of the median line.

In this curious form the median line overlaps the margin of the valve on either side, and prevents its being seen in this situation. The great convexity (and opacity of the dry) valve renders it almost impossible to resolve its striæ; although I have seen the longitudinal near the concave side of the median line. It is evidently allied to *Pl. rectum,* but

differs as much from it as is possible for two nearly allied forms to do.

Hab. Chibburn Mouth, Druridge Bay, abundant. This is the only locality in which it has occurred to me. In the Cresswell gathering, in which *Pl. rectum* was abundant, I could not find a single frustule of this species.

10. *Pl. arcuatum*, n. sp.—Valve very pale-brown, straight, broadly lanceolate; extremities produced into two long, obtuse, strongly arcuate beaks, curved in opposite directions. Length from 0·004″ to 0·0046″; breadth about 0·0005″. Striæ obscure. Median line straight, and terminating at the commencement of the extremities.

The long, strongly arcuate, and somewhat obtuse, extremities (resembling the *bill* of the *curlew, Numenius arquata*), and the short, wide body of the valve, distinguish the present species from *Pl. macrum*, to which, however, it is closely allied. It is, besides, much shorter than the latter species; never exceeding 0·005″, which is about half its length, according to the measurement of Professor Smith, given in his 'Synopsis.' The extremities, also, are much longer in proportion to the valve than in *Pl. macrum*.

Hab. Chibburn Mouth, Druridge Bay, and Cresswell, abundant.

COCCONEIS.

The species next to be described I have had some difficulty in referring to the present genus, in consequence of its frustules being *free*, and *not adherent* to the larger Algæ; a character which has been insisted upon by Ehrnberg, in the establishment of this genus, and adhered to by Professor Smith in his 'Synopsis.' The frustule in this species is also remarkable *in not having the median line central.* But in certain other respects it appears to me to be a true *Cocconeis.* I have therefore classed it as such, and have done so under the impression that, as our knowledge of the Diatomaceæ increases, it will be found necessary to extend the basis of distinction on which many of the present genera have been founded, in too limited and arbitrary a manner, in order that they may thus be made to embrace a much larger number of species, and thereby prevent the formation of new genera for the purpose of including every new form which may present certain structural peculiarities *apparently* anomalous.

11. *C. excentrica*, n. sp.—Frustules free. Valve disciform, convex near the margin. Median line not central, with terminal nodules not reaching to the margin. Striæ convergent, widely punctate, punctæ closer and more conspicuous

near the margin, thus forming a somewhat opaque and broad marginal band in the dry valve. Diameter from 0·001″ to 0·002″.

The eccentric position of the short median line seems to distinguish this species from every other member of the genus. The frustules are free, and have the power of moving. The endochrome is central, and of a pale-green colour, leaving the marginal portion of the valve with its radiate striæ distinctly visible. The dry valve is colourless, and the central portion much more translucent than the marginal. In balsam the opaque appearance of the marginal band becomes obliterated.

Hab. Linemouth, abundant; Cresswell, plentiful.

BACILLARIA.

12. *B. cursoria,* n. sp.—Frustules adherent, by means of some invisible connecting medium, into a filament, and having the power of moving, one along the opposed surface of the other. Form narrow, linear lanceolate, acute, with a central longitudinal line composed of thickly set, transverse punctæ, extending from one extremity to the other. Structure hyaline, not striated. Length from 0·0028″ to 0·0034″; breadth about 0·0004″. The only view which I have ever seen of this species is that which always exhibits the frustule with the central, longitudinal, and punctate line uppermost, as in fig. 12*a*. Whether this punctate line is situated on the middle of the S. V. and indicates a keel, or whether it extends down the centre of the F. V., corresponding with the intervalvular space, I am not prepared positively to decide, although I incline strongly to the latter opinion. My reasons for this opinion are the following:

First. Because a group of dry frustules preserving their natural, relative position, always presents each frustule to view with this line in the centre, and because *such a group* or filament always exhibits the F. V., and not the S. V., of each individual frustule. The same is seen in a *similar group* or filament of *B. paradoxa*; never the S. V.

Secondly. Because in frustules which appear to be undergoing the process of self-division, the punctate line is double, the distance between the two lines varying according to the degree to which the process has proceeded. (See fig. 12 *b*, Pl. III.)

This species is so abundant on the sands in some localities on this coast, that, in the clean gatherings from these, I have enjoyed frequent opportunities of observing the movement

which a filament of its frustules exhibits. The following are the facts which I have ascertained regarding this most remarkable phenomenon :

1. When the filament is in a quiescent state, the frustules are all drawn up side by side, their extremities being all in a line, thus forming a *group.*

2. When a filament, previously at rest, resumes its activity, the movement is commenced by the *second* or *inner* frustule, at one end of the filament, gliding forward along the contiguous surface of the *first* or *outer* frustule, until their opposite extremities overlap each other. This is soon followed by a similar movement of the 3d, 4th, and 5th, &c., all moving forward in the same direction, and each frustule gliding along the surface of the one preceding it, until they have extended themselves into a lengthened filament or chain. In the course of two or three seconds after this has been accomplished, a *retrograde* movement, exactly of the same character, begins to take place, and continues until the filament has retraced its course, and stretched itself out in a direction exactly opposite to the position it had previously occupied. This phenomenon is repeated again and again, and in this manner the whole group is kept in a state of activity for an indefinite period of time, and all the while, if no impediment produces irregularity, the *outer* or *terminal frustule,* next to which the movement commenced, *maintains a stationary and fixed position.*

3. The rapidity with which each individual frustule moves is in direct ratio to its distance from the terminal *stationary* frustule, being most rapid at the opposite or moving extremity of the filament. On this account, most of the frustules, while the filament is moving to and fro, cross a line drawn at right angles to the middle of the long axis of the stationary frustule, at the same instant of time, afterwards shooting past each other like horses on a racecourse.

4. The force with which the filament moves is very great, so much so, that I have observed it upset and shove aside a large frustule of *A. arenaria,* n. sp., at least six times its own bulk, obstructing its path. This force is, in a great measure, due to the rapidity with which the frustules move. The time which a filament, even of considerable length, occupies in crossing the field of the microscope being only a few seconds.

5. Light appears to be a necessary stimulus for the maintenance of this motion. When a filament, in active motion, is placed in the dark for a short period, and then examined, the movement is seen to have ceased ; but again commences

when the filament is exposed to the light for a short time. Is this singular movement, with which the present species is endowed, not a vital phenomenon and independent of physical causes for its existence?

6. When the moving extremity becomes entangled in any kind of substance intercepting its course, the opposite or stationary extremity commences to move, and continues to do so until the entangled extremity is set free; sometimes, in such instances, a frustule in the centre remains fixed, a movement of each half of the filament in opposite directions, on either side of it, taking place. But all these irregularities cease as soon as the impediment has been got rid of.

These facts lead to the conclusion that the present species is a true *Bacillaria,* although *apparently* somewhat anomalous in the structure of its frustule. The gliding movement of one frustule over the contiguous one is the same as is observed in *B. paradoxa.* But it differs from this latter species in this essential particular, that the *whole* of its filament *moves on one side* of a *terminal frustule which is stationary;* while in *B. paradoxa, each half* of the filament moves in *opposite directions* on either side of a *central stationary* frustule.

Whether the filament is at first *attached,* and afterwards *free,* as in *B. paradoxa,* I cannot positively decide, although I believe it to be *free,* owing to its only occurring in the shallow furrows on the beach, where there is not a single vestige of vegetable life, except the free species of diatoms with which it is mixed.

I think there can be little doubt that the form found by Professor Gregory in the Glenshira sand, and described as *Nitzschia socialis,* of which a group of frustules are figured ('Trans. Micr. Soc.,' vol. v, Pl. I, fig. 45) is another member of the same genus. "This species," he observes (*op. cit.* p. 80), "is remarkable from its occurring in the prepared material, after boiling with acids, in groups of six, eight, ten, or twelve, or more, without any apparent connection between them." Groups such as these, of the present species, are common on slides mounted from gatherings in which it occurs.

AMPHIPRORA.

13. *Apr. duplex,* n. sp.—F. V. rectangular, broad, rounded at the extremities, and very deeply constricted in the middle. Marginal plates also much constricted, and rounded at the extremities. Hoop broad. Structure exceedingly hyaline. Valve not striated, and without punctæ on either side of the

keel. S. V. narrow, linear-lanceolate, acute, exceedingly convex; keel strongly sigmoid. Length from 0·002″ to 0·0026″; breadth variable.

This form bears a strong resemblance to *Apr. alata,* in the contour of its F. V. But the absence of striæ in the valve and of punctæ on each side of the keel, together with the narrow linear shape of the S. V., prove it to be quite distinct from, though nearly allied to this species. The endochrome also is differently arranged from that of *Apr. alata.* The frustule undergoing division presents a very beautiful appearance, from the interlacing of the external surfaces of the contiguous and newly formed valves; as seen in fig. 13 *c.* A double appearance is thus produced. I may mention, as a curious fact, that nine tenths of all the specimens contained in a gathering from Druridge Bay, in which this species occurred abundantly, were in this double condition. This would show that the frustules remain adherent for a considerable period after being fully developed, by the process of self-division, which, in the present species, progresses with great rapidity.

EPITHEMIA.

14. *E. marina,* n. sp.—Form on F. V. rectangular, elongated; "*hoop*" on *dorsal* or *convex* surface of frustule ornamented with several longitudinal lines of round, distinct, and widely set punctæ; on *ventral* surface, hyaline. Length from 0·004″ to 0·007″; breadth from 0·001″ to 0·0018″. S. V. inflated, gently arcuate on outer or dorsal margin, on inner or ventral nearly linear, but slightly constricted in the middle; extremities suddenly produced, acute. Canaliculi conspicuous, 11 in 0·001″. Striæ 11 in 0·001″, widely punctate; punctæ large and rather inconspicuous. Dry valve a bright blue, in balsam colourless.

The fact of the "hoop" being hyaline in texture, on the *ventral* or *concave* surface of the frustule, and on its opposite, *convex* or *dorsal* surface, ornamented with six or more rows of large, round, widely set punctæ, as may be easily seen by carefully focusing, together with the peculiar incurved longitudinal line observable near the inner margin of each valve, shows that it is nearly allied to Professor Gregory's group of *complex Amphoræ.** But the outline of the entire frustule with its *inflated* valves, which appear to me to possess canaliculi and striæ which are widely punctate, have induced me, for the present at least, to include this large and beautiful

* 'Trans. Royal Soc. Edinb.,' vol. xxi, part iv, p. 47.

species in the genus *Epithemia*. With this opinion, I may mention, Professor Gregory concurs, while, on the other hand, Mr. Roper considers it to be a *Nitzschia*. But notwithstanding the high esteem in which I hold his accuracy and experience as a scientific observer, I cannot reconcile my views, on this point, with his. It seems to me, that this curious, and somewhat anomalous, form is without those essential generic peculiarities of the true *Nitzschiæ*, namely, compressed valves, with a keel to each, and its accompanying line or lines of punctæ.

AMPHORA.

In describing the following Amphoræ I have adopted the terms *dorsal* and *ventral*, as employed by Ehrenberg. These, though discarded by Mr. Ralfs and Professor Smith, are essentially necessary for the description of several recently discovered species of the present genus, in which the difference of structure, observable in each of these surfaces, is so great, that when a frustule is seen in a focus first shewing the one, and afterwards in a different focus exhibiting the other, the difference of appearance is so great that an observer, unaware of this fact, might readily suppose that he was looking at two widely different forms. This is well illustrated in fig. 15 *a* and *b*. The term "*hoop*" I have also used, in the same sense as employed by Dr. Carpenter,* to designate the siliceous plate intervening between the margins of the opposed valves. It will be observed that I have employed these terms, in the same sense, in reference to *Epithemia marina*.

15. *A. litoralis*, n. sp.—Form on F. V. oval, with truncate extremities. Hoop on dorsal surface broad, oval, slightly constricted, and marked with seven or more longitudinal lines of linear, transversely set punctæ; hoop on ventral surface linear, narrow, widest in the middle and at the extremities, hyaline. Length from 0·002″ to 0·003″; breadth from 0·0008″ to 0·0012″. S. V. dorsal margin arcuate, ventral linear; extremities obtuse; longitudinal line gently curved, situated some distance from the ventral margin, and dividing the valve into an outer and inner compartment; central nodule expanded into a strong, opaque, transverse bar, reaching to the dorsal margin. Striæ very distinct, moniliform; those of the inner compartment the finer.

The present species is evidently a member of Professor Gregory's group of *complex Amphoræ*. The *complex* structure,

* 'On the Microscope,' p. 303.

in this group, is apparently developed, only, in the hoop of the dorsal surface of the frustule, which seems to be constructed, like the bottom of a flattish boat, of several narrow longitudinal segments, which, like deals, are placed edgewise with their extremities convergent. This structure is well seen in fig. 15 *b*, Pl. III, and still better in *A. Grevilliana*, Greg., and *A. spectabilis*, Greg. The complex structure then is only observed as Professor Gregory has already pointed out "when the frustule is in a particular focus."

Hab. Chibburn Mouth, Druridge Bay; abundant.

16. *A. arenaria*, n. sp. — Frustule hyaline, colourless. F. V. rectangular; extremities slightly rounded; sides somewhat uneven, slightly bulged out in the middle and at the extremities. Length from 0·004″ to 0·006″; breadth about 0·0016″. S. V. convex, linear, dorsal margin rounded, near the extremities, towards the apices situated on the ventral margin. Central nodule some distance from the inner margin; longitudinal line much curved, first towards the dorsal, then near the extremities, to the ventral margin, where it joins the terminal nodules.

The F. V. presents a space of the shape of a sand-glass between the two gracefully curved longitudinal lines. This space, when the dorsal surface is in focus, is faintly marked with from six to eight longitudinal lines; the outer converging at their extremities. These indicate a complex structure of the frustule.

This large and interesting form is exceedingly hyaline and transparent when mounted in balsam. Mr. Shadbolt, who carefully examined specimens with a very high power, informs me that "it (the S. V.) is ornamented with markings of dots at right angles to the axis as well as parallel thereto; but these are of the most delicate nature, and discoverable with *difficulty* under the most careful manipulation with a $\frac{1}{12}$ objective of 165° aperture, and with peculiar illumination by the achromatic condenser."

The living frustule is remarkably beautiful; the whole being filled with endochrome, having a greenish apppearance, and collected in different places into large, bright-yellow globules. In the water the ventral surface is always uppermost.

Hab. Common along the southern portion of the Northumbrian shore. At Cresswell remarkably abundant, forming at least seventy parts in one hundred of the whole chestnut-coloured, diatomaceous mass with which the sinuosities in the sand, at low water, are covered.

NAVICULA.

17. *N. lineata*, n. sp.—Form of S. V. linear-elliptical, occasionally constricted a little in the middle. Striæ distinct, *costate*, and interrupted in the middle by a longitudinal, transparent line, running from one extremity of the valve to the other, nearly parallel with its margin; striæ also cut short, some distance from the median line, by another transparent longitudinal line parallel to the last, and succeeded by a line of indistinct punctæ. Median line broad, and bounded on either side by a narrow, rectilinear, transparent line. Length from 0·0023″ to 0·0035″; breadth from 0·0008″ to 0·0013″. Valve brown in balsam.

This species is easily recognised from *N. didyma* and its varieties by its *costate, bisected* striæ, and by the much larger blank space on either side of the median line; the constriction of the valve, when it exists, is also much slighter. Each half of the valve is divided into three distinct, narrow compartments, by three transparent lines running longitudinally between the extremities; the two outer being parallel to each other and to the margin, and the inner parallel to the contiguous median line. The two outer compartments each inclose a band of striæ, while the third or inner is hyaline, and bordered by a longitudinal row of indistinct transverse punctæ.

Hab. Cresswell Bay and Linemouth, abundant; not general in its distribution.

18. *N. æstiva*, n. sp.—Form gracefully elliptical; colour of dry valve blue, in balsam brown. Striæ fine, distinct, costate, or very obscurely moniliform, reaching close to the median line, and crossed a short distance on either side of it by a narrow, opaque, longitudinal line. Length from 0·0026″ to 0·0045″; breadth from 0·0012″ to 0·0022″.

This large and very beautiful species differs from *N. Smithii* in its much more gracefully elliptical figure, in its *costate* and much finer striæ, and in the much darker brown colour of the valve when mounted in balsam. *N. Smithii*, as it occurs on the Northumbrian shore, is a much smaller species, with rather coarse, moniliform striæ, and is nearly colourless in balsam when examined with a low power; it is likewise much more general in its distribution than the present species, and occurs in every strictly marine gathering which I have made.

Hab. At Cresswell and Linemouth, abundant.

Postscript.

Since the preceding pages were read before the Micro-

scopical Society I have, by the kindness of Mr. Roper, and of Dr. Montgomery, of Penzance, been favoured with slides of *Pl. rectum,* n. sp., gathered at Penzance. The former gentleman informs me that Professor Walker-Arnott has very recently discovered it there, and named it *Amphiprora Ralfsii.* But as my description of this form has already been made public, I have retained it in the present contribution. I must also add, that however reluctant I may be to dissent from so high an authority as Professor Arnott, yet I am convinced that this species is a *Pleurosigma,* and not an *Amphiprora.* My reasons for holding this opinion are as follows: 1st. Because the S. V. has a sigmoid appearance; the sigmoidure resulting from the opposite margin, near each extremity, following the convex curve of the contiguous median line. 2dly. Because the *structure* of the valve is that of a *Pleurosigma*—the striæ being distinctly *longitudinal* and *transverse,*—as may be observed without difficulty by using a good $\frac{1}{5}$ objective and the achromatic condenser with a central stop, aided by careful manipulation. In this way the striæ, though very fine, come out very sharp and distinct. The only evidence on which it appears to me the supposition rests of its being an *Amphiprora* is the contour of the F. V., which is keeled and constricted. But the discovery of *Pl. lanceolatum* and *Pl. carinatum* show that this character, apart from the *structure of the valve,* cannot be relied upon. In both these species the F. V. is very distinctly keeled, and as deeply constricted in the middle as most of the *Amphiproræ;* and yet their valvular structure proves them to be *Pleurosigmata*—the striæ being very distinctly oblique, and indicating the hexagonal areolation of one section of that genus.

These facts show that the outline of the frustule and of the S. V. is not sufficient to determine whether a particular species belongs to the one genus or to the other, and that in every instance the structure of the valve is the only character on which any reliance can be placed. The presence or absence of *lateral or marginal plates,* which Professor Gregory has recently shown to be so universally developed in the *Amphiproræ,* is also a feature of great importance, and will materially assist in the discrimination of species. In concluding, I may add that all the new species of *straight Pleurosigmata* described in this paper are closely allied to the *Amphiproræ,* and form a connecting link between this latter genus and the one to which they belong.

It is necessary here to add that, while these pages were passing through the press, I have been informed by Mr. Roper that *Pl. lanceolatum,* n. sp., Pl. III, fig. 4, is identical with

the *variety* of *Pl. transversale*, Bréb., described by him in the last (October) number of the 'Microscopical Journal'; that *Pl. lanceolatum*, however, is distinct from *Pl. transversale*, I think is proved by the fact that the former is the most common member of its genus on the Northumbrian shore, while I have never, yet, met with a single specimen of the latter. I may also state that De Brébisson considers it a distinct species; he has informed me, within the last few days, that in September, 1852, he discovered it on the sands at Dives, with many other species. But, unfortunately, he never published any description of these.

On a New Method *of* Mounting Objects. By Thomas Shearman Ralph, Esq., Wellington, New Zealand.

(Read November 12th, 1857.)

With the accompanying specimens which I have sent for the acceptance of the Society, I feel much pleasure in adding a few observations as to the mode in which they have been prepared, and the manner of mounting them. I have looked over all the papers and communications of the Society in the 'Quarterly Journal,' and I hope what I have to say may prove as useful to some of the members as many of their observations have been to me at this far distant point of the globe. And I trust what I may have to say, if not savouring of novelty or usefulness, will be acceptable, as a proof that I have not been idle in the interests of the Society.

The specimens, as those now sent, will be found to be mounted on perforated slides of glass—a plan which I saw put into practice some years ago, but which was then only adopted with wooden slides; but I think the present is a more suitable mode of mounting, as the glass is less likely to bend. I found considerable difficulty at first in making the preparations; but practice has made me more handy, and I am able to complete a sample in ten minutes. And as they are neater looking, I think they may supersede the use of the wooden ones. The method which I employ, when put into practice, will also enable any person to make cells of any required form or size, such as those in which tongues of the mollusca have been put up.

Take a slide, of as great a thickness as can be usually had,

and place under it a piece of blotting-paper folded so as to support the central square inch only, where the hole is to be drilled; have then prepared a steel instrument, called by watchmakers a broach, which is a five-sided, well-tempered tool, and sharpen it on a hone of some hardness (or on a a flint), so as to give it a three or more sided cutting end (this tool should be let into a cedar-pencil stick previously deprived of its lead and glued up again), dipping the point into oil of turpentine, place the end on the glass where the perforation is required, and endeavour to pierce it by a steady drilling movement; the first effect will be to break off a small piece of the surface of the glass, or, if the operator has been too rash, to break it into pieces. Once the surface has been thus scratched, proceed with the drilling, always keeping a drop of turpentine on the spot; in one or two minutes the drill should penetrate through to the other side. Sometimes I place my finger behind the spot where the glass generally drops out in a small piece before the point of the instrument. A small hole being thus made, proceed next with a fine rat-tail file, dipped in turpentine, and drill on, and use larger sized files till the required opening is made. *Mem.* These are standing rules: *Always* begin with a recently sharpened broach; *always* keep it and the files *wet* with turpentine, and in *screwing* the rat-tail file through the glass *always* use it with an *unscrewing* movement, as if you were using a turnscrew to take *out* a screw, for the reverse movement immediately *locks* the tool into the glass and a leverage is used, and the glass shivers into pieces; and *never* use the tool with any leverage against the edge of the glass. Two to three minutes more should suffice to drill through to the extent required (I have made myself a test tube-stand with holes large enough to hold the largest tubes made; and there are six or eight holes in the piece of glass); and the required evenness of the edges of the hole may be brought out by using a carpenter's *rose* or *counter sink,* previously sharpened, and *then* hardened in the fire to flint hardness. This is also to be used with turpentine, and in ten minutes from the commencement of the operation almost any person may have one ready for use. The other cells are made in the same way, only larger sized files and flat files are used, according to the fancy or need of the operator; but the edges of these cells do not require the labour of polishing off, as the faults are not discernible when the cells are filled with balsam; and if made of uniform shape or outline, they will be found to be quite neat enough.

A friend of mine here (an army surgeon) whom I have

inoculated with a passion for the microscope, &c., and who has turned out better specimens of all kinds than I have, takes the following plan, for two reasons: one, that the process is quicker; and the other, that there is less likelihood of breaking the glass. He has prepared a stout plate of brass about the same thickness as the glass, and this plate is perforated with such sized and shaped openings as he wishes to make in the glass. The glass is then cemented to the plate with melted shell-lac or wax, and when cold, a diamond is drawn round the opening in the plate so as to scratch out the size on the glass—this is done chiefly to limit the fracture of the glass. He then perforates the glass, in the manner I have already described, with the broach, and uses the rat-tail files with the most unsparing vigour, so as to shiver the glass to pieces as far as the marked outline of the cell. This is done in a minute or two, and then, polishing the edges a little, he soaks off the glass in a solution of soda, or melts off the cement. I strongly recommend any microscopist who is in the habit of making a variety of preparations, to make trial of this method. The method once acquired will prove useful to him in a variety of ways, as the size of the cell can be enlarged when there is none at hand but a small one; and too large cells are objectionable; cells just sufficiently large to hold a specimen are, to my mind, better than those which are more roomy.

The question was asked me when I was in England if I knew how to fill a cell with Canada balsam and leave behind no air-bubbles. I replied in the negative, and now I can state how to accomplish this. Fill the cell with clear spirit of turpentine, place the specimen in it, have ready some balsam just fluid enough to flow out of the bottle when warmed by the hand; pour this on the object at one end, and, gradually inclining the slide, allow the spirit of turpentine to flow out on the opposite side of the cell till it is full of balsam; then take up the cover and carefully place upon it a small streak of Canada balsam from one end to the other; this, if laid on the cell with one edge first, and then gradually lowered till it lies flat, will drive all the air before it, and prevent any bubbles from being included in the cell. It can be easily put on so neatly as to require no cleaning when dry. If the cover is pressed down too rapidly the balsam will flow over it and require to be cleaned off when hardened, for it cannot be done safely while fluid at the edges.

Minute specimens, I find, can be very easily mounted, free from air-bubbles, by placing first the object on the slide, and then the cover over it, and afterwards allowing the

Canada balsam, thinned down or diluted with chloroform, to flow in till the object is surrounded by this medium, and the whole space under the cover occupied by it. The chloroform rapidly evaporates, leaving the Canada balsam in the condition it was before mixture with the chloroform, and harder at the edges. *Mem.* This mixture of chloroform and Canada balsam should not be kept mixed as it is apt to become clouded after some time, although it has no prejudicial effect on the specimens when recently made.

The advantage attending this process is well worthy of note, *i. e.*, that no application of heat to the animal tissues is needed, and no coagulation of albuminous fluids, &c., can take place. Those who have laboured in making preparations of various kinds can scarcely have failed in encountering some specimens difficult of preservation, such as tongues of mollusca, and other oily or fatty subjects. These, it is generally known, may be cleaned by immersion in turpentine, but if heat be afterwards applied in putting them up, they are very apt to become turbid; hence the value of the above process. I soak such fatty specimens in turpentine till I find them clean enough, but before this I wash the specimen clean with a brush dipped in turpentine, or, if spirits of wine or water is used, allow the specimen to dry first, before subjecting it to the turpentine. The object having been so cleaned and laid out on a small piece of glass, such as a piece of broken slide, place another piece of glass over it, and secure them by binding it round with fine silver wire (such as may be obtained by unwinding a harp string), and place the whole in a jar or wide-mouthed bottle filled with turpentine. When well soaked for several days, or it may be for weeks, take out, and carefully brush the specimen, if it requires and will bear it, to free it from turbid matters at the edges. *Mem.* Long continued soaking in turpentine is apt to render some objects brittle, but if cleaning is not very requisite they are not too brittle to mount.

In this way I have treated the polypidoms of Polypi, and as these also contain air, I find they require no aid from heat or the action of an air-pump, as I have lately seen suggested, but merely due time for immersion in a *sufficient body* of turpentine. When the turpentine gets too dirty to do this work, it may do duty in grinding holes in the glass slides.

I have found certain animal substances still more refractory; as, for instance, the parasite of the Whale, which is exceedingly oily, and difficult to purify under the influence of turpentine. As a rule, if I find these specimens become

white or opaque under its action, I transfer them to rectified spirits of wine, and, after a good soaking, employ turpentine, and *vice versa.*

Again, the best way I know of preparing the feet of Insects, &c., is first to wash the feet, while the insect is alive, with spirits of wine, then holding it by a pair of forceps close to the edge of a clean piece of glass, the insect will lay hold of the upper surface by its foot, then suddenly drop another small piece of glass over it, so as to retain the foot expanded, and cut it off with a pair of scissors, tie up, and soak to get rid of air.

The tongues of flies are most easily made to protrude by pressing the head between the finger and thumb, over the eyes, or with a pair of forceps; the air appears to be forced into the trachea, and distends this organ freely, when it may be laid on a piece of glass, another placed over it, and *then* severed from the insect and subjected to the turpentine process.

With regard to vegetable tissues, I have had much difficulty, and shall be glad to obtain more information. My desire has been to obtain such a medium as will solidify or viscify around a specimen which has been previously prepared in glycerine, and such a medium must not disagree with the glycerine so as to exhibit oily globules, &c. At present, I cement glycerine contained in cells with mastic dissolved in creosote, the glass cover generally projecting over the edge of the cell, so as to allow the mastic to surround the edge of the cover both above and below. I am inclined to think that those glycerine-prepared specimens keep best which are mounted in a cell with a small bubble of air contained, as I think the glycerine does not escape so freely; the escape of glycerine from apparently well-secured cells, appears to me to be due to its great expansive property, besides its tendency to deliquesce.

March, 1857.

Since I wrote the above, some months ago, I have made a decided advance in the preparation of some insect-tissues. I adopt the following plan: Place the insect alive in sweet spirits of nitre; it will die rapidly, and the air will be freely expelled, partly by reason of the volatility of the medium, and those with a proboscis, &c., will protrude it. After soaking a day, the specimens are to be *rapidly* transferred to a small quantity of clean spirits of turpentine, when all the sweet spirits of nitre will be expelled in the form of globules charged with grease; immerse in a further supply of tur-

pentine in a clean bottle, and when the specimen has been a day or two (perhaps a longer time may be required for some), it can be mounted in the chloro-balsam, as I have described above.

Refractory specimens, or those which are very oily, may, after immersion in sweet spirits of nitre, and cleaning in turpentine, be again soaked in sweet spirits of nitre, when the turpentine will be expelled. If they are then a second time taken out of the sweet spirits of nitre and plunged in turpentine, the clearness of the globules which escape will indicate if the specimens are sufficiently cleansed. *Mem.* The sweet spirits of nitre must be fully expelled, or the Canada balsam will assuredly quarrel with it, and form a cloud round the object.

I am modifying the above plan by using sulphuric ether dissolved in three times its bulk of spirits of wine.

I inclose three specimens for the acceptance of the Society, with four slides, illustrating that part of the paper on perforated slides for mounting objects.

No. 1, is a slide done with a broach.

No. 2, a further stage, with the additional use of one file—both done in eight minutes.

No. 3, a completely finished, perforated slide.

No. 4, a cell cut out of a portion of a slide, and roughly mounted.

Report *of the* Sub-committee *of the* Microscopical Society *on the* Best Form *of* Universal Attachment *of the* Object-glass *to the* Body *of a* Compound Microscope.

(Read November 12th, 1857.)

The practical inconvenience that has arisen from the adoption, by different makers, of various modes of attaching object-glasses has long since been universally admitted.

In recommending a form of attachment for general adoption, it appears necessary to consider the following conditions:

1. That the greatest amount of truth be ensured, both in the centering and in the parallelism of the axes of the body and object-glass.

2. That the linear aperture be large enough to transmit all the pencils that can fall upon any field-glass in ordinary use.

3. That the fitting must be capable of construction in an ordinary lathe.

In order to ensure parallelism of the axes, a face-fitting is generally considered necessary. It also appears desirable that the *inside* fitting should be in the body of the microscope, and the *outside* fitting on the object-glass. Of the various modes of attachment that have been suggested, that which appears likely to fulfil most completely the conditions of perfect centering, is a cone of about 40°, surmounted by a screw which enters a loose nut placed above the hollow cone in the body of the microscope, but the practical difficulties of manufacture appear insurmountable; it is therefore proposed to relinquish the greater degree of accuracy that might thus be obtained, in favour of a mode of fitting that is at present partially in use, namely, a screw, surmounted by a plain collar or guide, for facilitating the application of the object-glass. As the correct centering must practically depend on the screw, it is strongly recommended that the inside and outside screws should both be cut by a traversing mandrel, or by a traversing slide-rest.

Having thus considered the form of the attachment, it remains to determine the most appropriate dimensions of the several parts. A screw, containing thirty-six threads in an inch, having an angular thread of 54°, slightly rounded off at the top and bottom, has been considered the most appropriate. The largest linear aperture, at the junction of the object-glass with the body of the microscope, will be required for objectives of low power having the widest compatible angle of aperture; this is not likely to exceed ·72 to ·73 in. with the greatest diameter of field-glasses now in use; hence, ·8 in. may be taken as sufficient for the external diameter of the screw. The length of screw recommended is $\frac{1}{8}$, or ·125 in., comprising $4\frac{1}{2}$ threads; and that of the guide or collar ·15 in.

In order to ensure uniformity of dimensions among different manufacturers, it has been thought desirable that an application be made to Mr. Whitworth to construct the requisite number of hardened gauges, of exactly equal dimensions, and he has kindly undertaken their construction.

The proposed set of gauges consists of a templet and ring of exactly ·8 in. external and internal diameters respectively; another templet and ring corresponding in diameter to the bottom of the thread, which Mr. Whitworth has determined to be ·7626 in., to be used as gauges for the plain parts of the fitting; and a master-tap or "hob" for cutting screw tools.

It is further recommended that a set of gauges should permanently remain in the custody of the Society, for the purpose of comparison, in case of any question arising as to correctness of gauge.

(*Signed*) George Jackson,
Charles Brooke.
H. Perigal, Jun.

At a meeting of the Microscopical Society, held on Wednesday, the 11th of November, 1857, it was resolved—

That this report be received and adopted.

It was stated by a member of the sub-committee that the three principal London firms had agreed to adopt the proposed gauges, which are now in the course of manufacture; and that any microscope maker might obtain them from Mr. Joseph Whitworth, of Manchester, at the cost of £2 10*s*. the set.

Precise Directions *for the* Making *of* Artificial Calculi, *with some* Observations *on* Molecular Coalescence, *supplementary to those on the same Subject, published in the 'British and Foreign Medico-Chirurgical Review' for October*, 1857. By George Rainey, Lecturer on Anatomy, &c., at St. Thomas's Hospital.

(Read December 9th, 1857.)

Since my paper on the "Elementary Formation of the Skeletons of Animals, and other hard structures formed in connection with living tissues," was communicated to the 'British and Foreign Medico-Chirurgical Review,' my attention has been directed to the improvement of the process for the obtaining of artificial calculi therein given. In this respect I have fully succeeded, and am now enabled to give a formula and directions, which if strictly followed will never fail to ensure satisfactory results. I have, besides, in course of experimenting, observed some facts with which I was unacquainted when I wrote my first paper. And as the subject is especially connected with microscopical science, I am anxious of bringing it more directly under the notice of the Microscopical Society. My present process differs from that given in the 'Medico-Chirurgical Review' only in having the exact quantity of carbonate of potass indicated, and the

precise densities of the two solutions specified. As several applications have been made to me, implying the want of explicitness in the first formula, I hope the tedious minuteness with which the details of the present process are given, will be excused.

This process consists in introducing into a two-ounce phial, about three inches in height, with a mouth about one inch and a quarter in width, either one ounce or half an ounce, by measure, of a solution of gum arabic saturated with carbonate of potass (the sub-carbonate of the old Pharmacopœas) of 1·4068 specific gravity, when one ounce of this compound solution will weigh 672 grains. The solution must be perfectly clear, all the carbonate of lime which had been formed by the decomposition of the malate of lime contained in the gum having been allowed completely to subside. Next, two clean microscopic slides of glass of the ordinary dimensions, are to be introduced, with the upper end of one slide resting against that of the other, and with their lower ends separated as far as the width of the phial will permit; and, lastly, the bottle is to be filled up with a solution of gum arabic in common water of 1·0844 specific gravity, one ounce of which will weigh 520 grains. This solution must also be perfectly clear, having been first strained through cloth, and then left to stand for some days to allow of the subsidence of all the floating vegetable matter. It must also be added gradually to the alkaline solution, that the two solutions may be mixed as little as possible in this part of the process. The bottle must now be kept perfectly still, covered with a piece of paper to prevent the admission of dust, for three weeks or a month. Time would be saved by employing a dozen bottles thus charged, and examining their contents at stated intervals according to the chief object sought for in the experiment. The soluble salts of lime to be decomposed by the subcarbonate of potass are contained in the gum, in combination with malic acid, and also in the common water. Muriate of lime dissolved in a solution of gum from which all the lime had been previously separated would answer a similar purpose, provided the quantity of muriate were not in too great excess for the gum, when crystals of carbonate would be formed with the globules, and the surface of the slide would become covered with coalescing patches of the latter.

But there is another crystalline compound in gum, which, when I wrote my first paper, had not occurred to my notice, and which, combining with the globules of carbonate of lime formed at the lower part of the slide, contributes to the for-

mation of the largest and most beautiful calculi, and which are connected with some very singular facts tending to throw light upon the subject of crystallization. This compound is the ammoniaca-magnesian or triple phosphate. I am not aware that this salt has ever been noticed before in gum arabic; but the existence of all the elements entering into its composition are mentioned in the analysis of gum by several chemists. (See Turner's 'Chemistry,' p. 855.) It is thrown down by the excess of subcarbonate of potass ordered in the formula, for if no more of that salt were added to the gum than just sufficient to neutralize the vegetable acid in combination with the lime, the triple phosphate would be retained in solution. Hence this substance, not beginning to be deposited until after the carbonate is formed, occupies a place on the glass slides, just beneath the lowest particles of the globular carbonate with which it combines, forming a compound of carbonate of lime, gum, and triple phosphate all molecularly, and now, I believe, chemically, combined. But this latter fact would require a more accurate analysis of the compound than I have yet been able to make. The examination of these slides shows what is taking place in different heights in the solutions during the progress of their diffusion; and from the downward direction in the surface of the slide upon which the globules to be examined are deposited, they become attached to it as the result of their motion upwards—the necessary consequence of the diffusion of fluids of unequal densities so placed one with respect to the other. And the success of the process for forming the largest and most perfect globules will require that the adjustment of these densities be such that the two compounds—the globular carbonate and the triple phosphate—should be formed as nearly at the same time as possible, and at the same height in the fluid, and that they should remain suspended until all the smaller globules in the same vicinity have become attracted by, and incorporated with, one another. After which some of the larger ones thus formed will fall to the bottom of the bottle, whilst others, being attracted by the surface of the glass, placed in an inclined plane above them, will become adherent to, and blended with it, so that after their separation a mark will remain permanently on the glass, having the form of the part of the globule which had thus been connected with it. If the alkaline solution be too thick, and the simple solution of gum not sufficiently so, the alkali will ascend more rapidly in the bottle than the gum, which not being sufficient in proportion to the quantity of carbonate formed to prevent the crystalline arrangement of its molecules, regular crystals of carbonate of lime will

result. These, however, will only exist towards the upper part of the slide; and examined from above downwards, they furnish an opportunity of seeing all the changes which the form of the crystals of carbonate undergo as they become combined with a successively increasing proportion of glutinous material. The particles, as thus examined, will be seen passing through all forms intermediate between the perfectly rectilinear figures and true spheres. (See Plate IV, fig. 1.) If, on the contrary, the density of the alkaline solution be not sufficient, the globules will fall to the bottom of the bottle too rapidly to coalesce in sufficient numbers to produce large calculi. When the densities of the two solutions are properly proportioned, as in the formula here given, the globular carbonate, without triple phosphate, will be found chiefly at the upper part of the slide, and the combination of the two at the lower. And still lower down are the crystals of triple phosphate unmixed with carbonate. Sometimes these crystals are very minute and imperfect, whilst at others they are larger, and exist in a perfectly crystalline state, increasing in size as they are deposited higher up on the slide until they come into the vicinity of the globules of carbonate, when they gradually loose their rectilinear form, and become so thoroughly incoporated with one another, or with the globules with which they are brought into contact, as to lose all traces of their previous crystalline arrangement (fig. 1).

It may seem singular that gum should have the power of opposing the rectilinear arrangement of the molecules of carbonate of lime, and not of triple phosphate or of phosphate of lime, as mentioned in my first paper, to which I must here refer, although each is equally in contact with the gum when it assumes its solid form. This probably arises from the carbonate of lime having a chemical attraction or affinity for the gum, and therefore combining with it, whilst the triple phosphate has not; and therefore, this substance not entering into intimate molecular union with it, the cohesive attraction between the molecules of the gum cannot influence effectively the repulsive force acting upon the ultimate molecules of the triple phosphate; but when the triple phosphate is brought into contact with carbonate of lime combined with gum, which has been shown to have a strong attraction towards solid bodies, as is seen, for instance, by its action on glass, then the molecules of triple phosphate becoming, through the chemical agency of the carbonate of lime, in more intimate union with the molecules of the gum, and now having the repulsive force separating them overcome or neutralized, are brought under the effective influence of the attraction of gravitation; so that the globular compound of carbonate of

lime and gum act in the same way upon the triple phosphate as the simple gum did upon the pure carbonate of lime. Now a very simple fact will show that this reasoning is correct, and that the repulsive force acting upon the molecules of the triple phosphate, as also upon those of the pure carbonate in these compound globular calculi, is not destroyed, but only overbalanced by the cohesive attraction of the gum, and is there ready to display its repulsive power upon their molecules as soon as this balance is destroyed and a preponderance given to the repulsive agent. The fact here alluded to is shown by the immersing for an instant of a slide, on which calculi of triple phosphate combined with globular carbonate, and calculi of globular carbonate without triple phosphate have been formed, in any liquid heated to 212°, as, for instance, distilled water, turpentine, olive oil, Canada balsam, &c., when the molecules of the former of these calculi will instantly start from the curvilinear to the rectilinear arrangement, that is to say, will pass into well-defined crystals of various sizes, and of a more or less rhomboidal figure, whilst those of the latter calculi—the globular carbonate—will not be in the least affected. The explanation of this fact appears sufficiently obvious. In the calculi containing the triple phosphate combined with the globular carbonate there is a smaller proportion of gum than in the globular carbonate calculus, and hence the excess of the attractive over the repulsive force may be presumed to be less in the former than in the latter calculi; so that if the forces of attraction be equally weakened in both kinds of calculi at the same instant, one may pass into the crystalline state, whilst the other retains its globular form, as shown in the experiment. Now it is only necessary to suppose that heat, in this instance, has weakened these attractive forces.*

It seems to me that this experiment, in conjunction with the facts connected with the conversion of the crystalline into the globular form of carbonate of lime and ammoniaco-magnesian phosphate, by the action of a substance possessing a particular kind of cohesive attraction (for I may observe that gum is not the only substance which produces this effect), furnishes both analytical and synthetical evidence in proof of the correctness of the principle advanced in this and in my first paper. (See 'Medico-Chirurgical Review,' for July, 1857.)

After the slides have been withdrawn from the bottles, all

* It was my intention to have made some observations upon the probable nature of the repulsive force and its action in the production of crystals; but as such observations could only have been of a speculative character, I have thought it best to omit them.

the globules deposited on their upper surface may be rubbed off with the finger, and this surface, if necessary, washed with hydrochloric acid, care being taken that it does not touch the edge of the slide, and so reach the opposite surface. Afterwards, the lower surface, this having the clearest globules upon it, must be well washed for several minutes by a stream of water running from a tap, so that all the gum may be removed. It will then be necessary to wash it in distilled water, in order that no deposit from the impure water may be left on the glass. The specimen should now be dried on a plate over boiling water, especially if it is to be put up in Canada balsam, and washed with oil of turpentine. The Canada balsam must not be boiled on the same slide, as the globules containing the triple phosphate would, in that case, become filled with rhomboidal crystals, as before observed, but the inspissated balsam may be poured hot upon the calculi from another slide. Lastly, a thin glass cover, of the width of the slide, may be put upon it, resting at each end upon a ledge of thin glass. The calculi which remain in the bottle may next be examined. Those of the largest size are not quite so clear as those on the lower surface of the slide; but the rest, which are of all sizes, especially the very small ones, are much more accurately elliptical than those adherent to the surface of the glass—the mechanical conditions under which they are formed being less disturbed by the attraction of adjacent objects. The internal ellipses, also, and all other points indicative of the manner in which they were formed, are more recognisable in those which have subsided from the fluid in the bottle. There are, among these, calculi which have remained in the solution of gum for about a year, very large, generally dumb-bell shaped ones, of a transparency almost equal to that of glass. They especially resemble the very early deposits of the shell of the oyster.* Of these elliptical particles which are adherent to the slide, one of the poles, being blended with the substance of the glass, seems to be gradually shaded off, and is thus made to appear imperfect; this molecular union with the glass furnishing an example of the remarkable tendency which the carbonate of

* They exhibit somewhat of a nacreous appearance, being irridescent when seen by transmitted light; but by polarized light, though showing a very distinct cross, they do not exhibit prismatic colours. This I believe is to be accounted for by their cohesion being so perfect, that the molecules, though attracted in straight lines by the force of gravity, are still capable of resisting a force of repulsion which in a lower state of cohesion would bring them into a crystalline condition; which condition is, I believe, the cause of the exhibition of the prismatic colours in the other, larger calculi as seen by polarized light. (See plate, &c.) These calculi undergo no change by being boiled in distilled water.

lime has to combine with hard substances. The slide upon which these particles have been formed is permanently marked by the part of the globule which had thus been attached to it. The particles on a slide, where the experiment has perfectly succeeded, come in the following order, taking them as they are seen from above downwards. First come the minute spherules and dumb-bells, which get larger as they are situated lower on the glass; next, the particles are seen to get smaller, though of a more perfectly spherical form, and here begin to be mixed with very large globules. These, having the most carbonate in their composition, exhibit a laminated arrangement, whilst those which are chiefly composed of triple phosphate have their surface nodulated, being studded with minute crystals; this is especially the case in the calculi which have been several months in the solution; lastly come the crystals of triple phosphate passing into a globular form, being mixed only with a small proportion of globular carbonate; and, last of all, are the crystals of pure triple phosphate, with their sides and angles beautifully sharp and well formed. These appearances, and the proportions in which these several kinds of globules exist, will vary in different specimens, depending probably upon differences in the composition of the different kinds of the gum employed in the experiment, as well as upon other accidental causes.*

There is yet another description of artificial calculi presenting characters differing in many respects from those already described, prepared by dissolving one pound of gum arabic in two pints of water, and straining the mucilage through a fine hair sieve, and then putting one pint of the solution with two ounces of subcarbonate of potass, well mixed together, into a quart bottle, and after twenty-four hours adding, by means of a syphon, the other pint of mucilage,† and after that leaving the bottle at rest for six weeks or two months, when the calculi will be found adherent to its sides, or in the fluid at the surface.

* Besides these, there are other crystals formed in these solutions, but they are all soluble excepting those of bicarbonate of lime, which are produced by some of the carbonate becoming combined with the carbonic acid set free by the action of the acetic acid upon the subcarbonate of potass. The quantity of the acid being the result of the acetous fermentation, is most abundant in warm temperatures. All crystals produced by double decomposition in a solution of gum, which do not combine chemically with it, are large and well-formed; hence such a process may be taken advantage of to crystallize some salts, otherwise difficult of crystallization.

† It may be observed that in this instance the insoluble particles floating in the mucilage will not have had time to fall to the bottom of the bottle.

These calculi are very large, being $\frac{1}{80}$th or $\frac{1}{60}$th of an inch in diameter, and spherical, excepting sometimes on the side which was in contact with the glass, which is flattened. They are beautifully laminated, and coalesce in the same manner as those before described. When treated with weak acetic acid they effervesce, and leave a residue of amorphous matter. When dried they retain their globular figure, but have not the smooth and glassy appearance of those formed on the slides. Under polarized light they present a cross and appear somewhat coloured, but do not exhibit the prismatic colours. They cannot be preserved in any fluid, as they suffer disintegration and gradually disappear. Even if they are put up in a cell with the solution of gum in which they were formed, still they gradually, though only partially, suffer disintegration. All the carbonate of lime disappears, but a residue is left having the same laminated appearance (though seen very faintly) as the original calculus, but this residue is not in the least visible by polarized light. These peculiarities are, I have no doubt, due to the presence of a quantity of insoluble vegetable matter intimately mixed with the particles of carbonate, which prevents that complete coalescence which otherwise would have taken place; and hence in these calculi the molecules are kept together with but a very feeble cohesive attraction, as is indicated by the absence of that degree of transparency which characterises the other forms of artificial calculi when perfectly dry. Hence it is probable that the force which keeps these heterogenous particles together is chiefly, if not entirely, the attraction of gravitation. Consequently when they are removed from the bottle in which they were formed, where all the molecules entering into the structure of each of them would have been exactly balanced between the mutual attraction of the molecules themselves, and that exerted upon them by the various part of the bottle, to a small cell of glass where they will be brought into much closer contiguity with surrounding objects, this balance will be destroyed, and the molecules, being now attracted by surrounding substances more forcibly than by one another, their separation will ensue. The vegetable matter molecularly united with the carbonate of lime being very light, and probably having a slight cohesive attraction existing between its own particles, will retain its place, whilst the particles of carbonate will become attached to the sides of the cell. I consider that there is nothing wonderful either in the facts here stated respecting these calculi, or in the explanation of them here advanced. It is only just what might have been anticipated under such circumstances,

and it is exceedingly probable that a process very similar to this frequently takes place in living structures, and that many of the facts presented by the molecular disintegration of living tissues, and usually attributed to the direct influence of a vital force, are the immediate effect of a mechanical agency. One thing is certain, that where the conditions necessary for the operation of physical forces upon the molecules of matter are present, whether in organic or inorganic substances, these forces do act either effectively or ineffectively. Vitality may oppose, modify, or direct their operation; but there is no reason to believe that it ever either creates or annihilates them. The force of gravity, or universal attraction, would want its most distinguishing attribute, if every molecule in the universe were not, at all times and in all places, under its influence; and it is illogical to suppose that in the case of vital organisms a distinct force exists to produce results perfectly within the reach of physical agencies, especially as in many instances no end could be attained were that the case, but that of opposing one force by another capable of effecting exactly the same purpose.

For a full discussion of the question of molecular coalescence, as applied to the hard structures of animals, I must again refer to my former paper in the 'British and Foreign Medico-Chirurgical Review;' but from what has just been stated, it would be unreasonable to conclude that this process ends there, and that the skeletons of plants, as well as all soft structures, both animal and vegetable, are not equally under its influence. Many considerations appear to me to justify the inference that the constituent materials act upon one another, and are acted upon by the physical forces in the same way in plants as in the shells of animals. And as to the effect of coalescence on the molecules composing soft structures, it must of necessity be the same as on those of hard ones, unless it be a fact that the physical laws which act upon matter in a feeble state of cohesion, are not the same as those laws which act upon it when this force of cohesion is augmented. It is true that the process of coalescence in soft structures does not admit of that rigid demonstration which it does in hard ones, in consequence of its being in the latter so slow and gradual as to afford ample opportunities of our observing it through all its stages, whilst in the former it would take place too suddenly to leave any traces of the precise manner in which it had been effected. And most probably the real nature of this process would never have been understood if it could not have been demonstrated on artificial products; for although there are evidences of its real nature in the calcifying shells of crusta-

ceans and molluscs as demonstrative of the manner in which it is produced, as in the artificial specimens, still these occurring in contact with living structures, would always have left a doubt as to what part of the phenomenon was due to vital and what to physical agency, and thus the question would have remained a debateable one. And certainly the cytoblast theory of Schwann and others—the very foundation-stone of modern histology—would have contributed nothing towards the solution of this difficulty, or ever have led to the discovery of the fact, that the process of calcification in the shell of a crab or an oyster is a directly physical one.

On a PROBABLY NEW SPECIES *or* FORM *of* ACTINOTROCHA, *from the* FRITH OF FORTH. By T. SPENCER COBBOLD, M.D., F.L.S., Lecturer on Botany at St. Mary's, London.

(Read at the Microscopical Society, December 9th, 1857.)

IN the autumn of 1856, I procured from the south shore of the Frith of Forth, near Portobello, three examples of an animalcule, which, on microscopical examination, at once reminded me of Müller's *Pluteus paradoxus*, and other allied forms of echinoderm-larva described by him in the later volumes of the Berlin Academy's 'Transactions.' However, on recently going over these various memoirs, and comparing his figures with those here reproduced (Plate IV, figs. 10, 11, 12), I felt inclined to doubt the correctness of my original conception of its larval condition, and was thereupon induced to assume that it might with greater propriety be referred to the group of Polyzoa.

Although it should be fully proved to be a true echinoderm-larva, the remarkable analogy subsisting between Professor Allman's typical polyzoon and the creature under consideration, must be apparent to the most superficial observation. Commencing from above, the following parts may be recognised. In the first place, we have an enormously developed *epistome*, forming a kind of beak, which when closed or shut down rests upon a slightly convex *lophophore*. The latter is armed with numerous tentacula, clothed with highly active vibratile cilia, and is succeeded by a more or less funnel-shaped body, terminating abruptly at the caudal end. The margin of this disciform extremity is occupied by a slightly projecting ciliated band, and the anal orifice is placed in the centre. The stomach and intestine, though simple and continuous, are distinct from each other, and traces of additional viscera may be recognized. By reflected sun-light the tissue of the ciliated band is seen to contain a number of highly refracting corpuscles of a golden yellow colour.

Such, in brief, are all the facts I am enabled to give in regard to the organization of these interesting little animals. A more lengthened examination would probably have supplied me with further particulars; but having been anxious to watch their further development (at the time assumed possible), they were placed for this purpose in a small glass aquarium, in which situation they so effectually concealed themselves in a tuft of *Enteromorpha*, that I never afterwards succeeded in finding them. While on the move, they frequently displayed a most eccentric attitude, and when motionless, they rested on the caudal extremity in an upright position (figs. 2 and 3).

In answer to some inquiries respecting the polyzoal relations of this larva, Professor Allman has kindly furnished me with the following particulars:—"It appears to me," writes Dr. Allman, "that there are so many points which militate against its being a polyzoon, that I do not at all feel disposed to place it in that group. The lophophore and epistome seem in favour of its polyzoal relations; but then we have the same organs in *Phoronis*, and the epistome here seems to me, if I rightly understand your figures, not to be homologous with the epistome of the Polyzoa, as it here looks *towards the concavity* of the lophophore, while in the Polyzoa it looks *towards the convexity*. Then there is no distinction between a retractile and fixed portion (polypide and cell), and no system of muscles such as we find in the Polyzoa, while the position of the arms is so very different, as, I think, in conjunction with the other points, to decide against our associating this creature with the Polyzoa."

Until very recently, I was not aware that a form of animal very similar to that I have here imperfectly described and figured, had been noticed by J. Müller, and others, under the name of *Actinotrocha branchiata*. My attention having been drawn to this circumstance by Dr. Carpenter, I find, upon reference to Müller's paper contained in his 'Archiv' for 1846, p. 101, that there can be no doubt that the creature found by me in the Frith of Forth belongs, at any rate, to the same generic type as his *Actinotrocha branchiata*. In the same journal for the subsequent year, 1847, some additional observations on the same animal are given by Wagener, whilst two apparently distinct forms are briefly noticed by Gegenbaur, in Siebold and Kölliker's 'Zeitschrift für Wissenschaft Zool.,' vol. v, p. 347. From all of these, however, I am inclined to think that the form here noticed presents sufficient differences to justify its being regarded as representative of a distinct species, though obviously belonging to

the same generic type. In the absence, however, of more precise knowledge than we at present possess, of the growth and development of these creatures, it is perhaps premature to offer any speculations upon its true relations. And, as suggested by Gegenbaur, with respect to the *Actinotrocha* described by him, the differences in the forms already noticed may be due to their having been observed in different stages of growth or development. The general opinion seems inclined to regard *Actinotrocha* as a larval form of some kind, and most probably of an echinoderm. Amongst those who have entertained this opinion, I would adduce Von Siebold, who compares *Actinotrocha* with a *Bipinnaria* from which the perfect asterid has become detached (Wiegmann's 'Archiv,' 1850.) At present we cannot be surprised that the true relations of this creature should be very obscure, but may remember that in the same paper in which J. Müller notices *Actinotrocha,* he for the first time describes a *Pluteus,* without then having any comprehension of its marvellous relations to the Echinodermata, subsequently ascertained by his unwearied researches in that and other allied forms—researches which have added so immensely to natural knowledge, and contributed another imperishable wreath to the well-won fame of the illustrious physiologist.

[*Note.*—At the meeting of the Microscopical Society, at which the above paper was read, Dr. Carpenter exhibited a specimen of *Actinotrocha* (apparently *A. branchiata,* Müller) preserved in dilute glycerine, and the inspection of which further confirmed the opinion above expressed, that the form described by Dr. Cobbold differed from that species in several important particulars, and more especially in the shape of the hood or epistome, and in the number of tentacles around the body. Dr. Carpenter also stated that the form shown by him was extremely abundant in the Isle of Arran, and probably elsewhere, so that it is to be hoped that opportunities will be taken to search for and examine this and allied forms, at different seasons of the year, on various parts of the coast. —EDS.]

TRANSACTIONS.

On some Diatomaceæ *that are found in* Noctiluca miliaris, *and the best means of obtaining them.* By Colonel W. H. C. Baddeley. Communicated by Mr. F. C. S. Roper, F.L.S., &c.

(Read April 20th, 1858.)

While engaged in endeavouring to ascertain the mode of reproduction in *Noctiluca miliaris,* I remarked in all fresh specimens of this creature a mass of dark matter near the nucleus, and on a closer examination found it consisted chiefly of Diatomaceæ. This has before been casually noticed by Mr. Brightwell and others; it is therefore mainly for the purpose of inducing others along the coast to examine these creatures for the sake of the Diatoms they contain, that I send the method I employ to capture them, and some of its results.

The Diatoms lie in the so-called vacuoles, which the creature appears to have the power of moving by means of the threads to which they are attached. By this arrangement the vacuoles are brought towards the apparently slit-like opening of the mouth to receive the food, and are afterwards drawn back again into various portions of the body. Having ascertained of what this food consisted, it occurred to me that here was an easy method of obtaining different marine species of Diatoms, and I at once tried to ascertain the best means of securing a good supply of these interesting little animals. I adopt the following plan:

Attach a fine muslin net to the end of a light pole, and proceed to some spot where the Noctilucæ are likely to be driven.

A breakwater which causes an eddy to collect Medusæ, &c., generally yields a good harvest.

Skim the surface, and wash the net repeatedly in a can of salt water; at night, these creatures are easily seen by their luminosity; by day, if plentiful, they cover the surface of the sea in brownish streaks.

Having secured what is required, return home, and pour the water into a white hand-basin, allowing it to stand an hour or two. This rough treatment causes these creatures to disgorge their food, and if, after an interval, the water be carefully poured off, a sediment will be found at the bottom, which will consist of Diatoms mixed with some refuse.

A portion of this can be examined in this state; another portion, after being well washed in fresh water; and the remainder treated with acid as usual.

The result of the examination of the first will probably show many species of Diatomaceæ in their natural state, often alive, and with the Endochrome perfect. It is by this method that I have found several rarer species in their normal condition.

The best winds in which to capture these creatures appear to be those from south to west—during their prevalence I have taken Noctilucæ every month of the year on the east coast of England; but it is during the summer months that they are most abundant, and during calm weather.

Abroad, they are constantly to be met with in warm latitudes; and I feel confident some interesting results might be obtained by securing this creature in various parts of the world.

I now beg to mention some of the species I have found by the above-mentioned means:

Coscinodiscus radiatus.
,, concinnus.
,, eccentricus.
Eupodiscus argus.
,, subtilis.
,, crassus.
,, radiatus.
,, tesselatus.*
Actinocyclus undulatus.
Triceratium favus.
,, undulatum (and varieties).
,, alternans.
,, malleus.
,, striolatum.
,, newspecies, not named.
Campylodiscus costatus.
,, cribrosus.
Surirella fastuosa.
,, gemma.
Amphiprora didyma (and another species, not certain).
Navicula palpebralis.
,, elegans (and some others).
Pinnularia distans.
Stauroneis pulchella.
Doryphora amphiceros.
Tryblionella punctata.
Striatella unipunctata.
Pleurosigma elongatum.
,, rigidum.
,, formosum.
,, fasciola.
,, balticum (and several others).
Two or three Asterionella.
Rhizosolenia styliformis.
,, setigera.
Biddulphia rhombus.
,, aurita.
,, Baileyii.
Amphititras antediluviana.
Bacillaria paradoxa.
Eucampia zodiacus.
Grammatophora serpentina.
Several species of Melosira.
,, Podosira.
,, Orthosira.
Chætoceras (?), (also several others, of whose true name I am uncertain).

The above-mentioned species, however, will give some idea of the nature of the gatherings to be expected.

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* I am endeavouring to ascertain to what species the several discoid forms attached to each other by stipes belong, and which are found in these gatherings.

On MICROSCOPIC OBJECTS *collected in* INDIA, *&c.*

BY G. C. WALLICH, M.D.

(Read April 20th, 1858.)

WHILST availing myself of the opportunity so politely afforded me, to lay before you this evening the general outline of a microscopic collection recently brought home by me from India, I feel that some apology is due for the unsystematic manner in which I am compelled to submit my observations and drawings to your notice. You will grant me your indulgence, however, I feel assured, when I state that I came up to town a few days ago, without the remotest idea that you would honour me with your attention on the present occasion.

I would beg you, therefore, to view my communication and figures as mere rough notes, the valuable portion of which has yet to be eliminated; and I would further ask you to bear in mind that my collection has been made under numerous difficulties, either whilst rapidly marching through the Bengal Presidency, or on shipboard, in the absence of libraries or museums to consult, and what is still more disheartening, in the absence of even one fellow-labourer, with whom to compare notes or interchange ideas.

In the Bombay and Madras Presidencies, I am aware that the subject of Microscopic Natural History has been sedulously cultivated by a few, and with highly valuable results. But in Bengal, I fear, little or nothing has been done, notwithstanding the widely extended and varied field that there presents itself for researches of this kind. This is the more to be regretted, inasmuch as few portions of the globe, in all probability, hold out greater facilities for the study of all microscopic organisms; and both as regards temperature, moisture, rich soil and abundant water, Bengal offers especial opportunities for the investigation of their progressive development and "Life History."

You will hardly be astonished, however, when I state that encouragement towards this department of science has hitherto virtually been withheld, on the principle that all kinds of research, to be of value, must exhibit *primâ facie* evidence of being likely to pay. The question is therefore

not unfrequently asked, what substantive benefit can possibly accrue from investigations into the minute world?—a question, I humbly submit, absurd enough to rouse the bile of the most stolid microscopist under the sun.

But these drawbacks, gentlemen—disheartening as they are to some extent—possess their compensating advantages, for whilst they act in the light of a Microscopic Game Law, they enhance the delight with which the adventurous trespasser revels in so boundless and untrodden a field. He finds himself peering into a new world, beautiful and rich as his own, and he comforts himself with the conviction that, however little encouragement and sympathy may be accorded him on the other side the ocean, the deficiency is amply made up for on this.

As far as quantity goes, therefore, I have every reason to be satisfied with my fortune. But, gentlemen, I am painfully alive to the fact that scanty credit is due to the mere collector—to him who, having the opportunity thrust upon him, as it were, simply stretches forth his hand, accumulates material, multiplies species, often beyond all due limits, and winds up by an extensive contribution to the cacophonies of nomenclature—whilst legitimate reputation can only follow on the far more laborious and far more difficult task of working out, step by step, the physiological development and true relations of the structures that present themselves.

It is not therefore without considerable diffidence that I submit to the Society, in their present crude and unsystematised condition, the drawings and notes before you.

With regard to the probable number of new forms that have fallen under my observation, I feel it would be rash, as yet, to hazard even an approximate estimate; for, difficult as is the identification, in many instances, of the varieties of the best understood species, that difficulty becomes materially heightened when the diversified forms of less definite or unknown species exhibit themselves, under the influences of extremely rapid and luxuriant tropical growth.

I would observe that nearly the whole of the Desmidiaceæ figured by me, were gathered in two or three months, during the Santal rebellion, within a circumscribed district about 120 miles above Calcutta. It is easy to conceive, therefore, how amply the more general survey of Lower Bengal would repay the inquirer, who, having leisure and perseverance at command, simply enforced the will.

Again, the chief portion of the strictly Indian Diatomaceæ was derived from the Sunderbunds or Delta of the Ganges,

a locality from which we might naturally anticipate highly interesting gatherings. But, beyond the tidal influences, the Diatomaceous forms of Bengal are peculiarly general. Indeed, along the entire Gangetic valley, they may be said to be so—a circumstance in all probability resulting from the extensive character of the annual inundation, which, sweeping across river and plain, converts the entire surface of the country, at times, into a vast inland sea, and of course favours the distribution of each minute organism throughout the entire range of its occurrence.

During the rains also, as the mountains contribute largely to these inundations, it is not to be wondered at that forms detected in the hill lakes and rivulets gradually find their way down into the plains below, and by degrees become acclimatized there. Indeed few species occur in the mountain lakes, such as those about Nynee Tal and Almorah, that are not also to be found in the plains. But it is remarkable that one well-defined species, which occurs somewhat sparingly in the lakes referred to, is completely lost sight of throughout the entire length of the Gangetic Valley, and reappears, strangely enough, in profusion amidst the brackish channels of the Sunderbunds, at a distance of 1200 miles.

Another species, well known in this country, and, if I apprehend aright, frequenting only brackish water, is not only common to the plains of Bengal, but presents itself in the same mountain lakes, and also in the primæval wilderness of the Delta.

I mention this fact to show under what widely differing circumstances species may exist, and still retain their specific characters unimpaired; and that the mere fact of a peculiar habitat *may* not, after all, be so useful in determining species as has by some observers been laid down.

My marine gatherings, I would mention, were made during the voyage round the Cape, in a sailing ship, under peculiarly favorable circumstances to the microscopist, though not so to the navigator; inasmuch as frequent calms, both in the Bay of Bengal, Indian Ocean, on the Lagalkas Bank to the southward of the Cape, at St. Helena, and off the Western Isles, afforded constant opportunities for using the casting net, towing net, or dredge, as the case might be.

Of course, from the open sea, the purely microscopic forms, with a few exceptions, could only be obtained by having recourse to the floating living creatures of various kinds that abound on the surface, under certain circumstances, in almost every latitude. It was only when going rapidly through the water, that is beyond five or six knots an hour, that it

became difficult or impossible to seize upon some of these creatures. In the heaviest gales, off the Cape, so long as the wind was ahead, some one or other of these would present itself in the net, and rarely were their stomachs barren. But the question, gentlemen, I presume, is not from what source may we derive material, but from what can we not do so, when even the lazy turtles we caught napping in a calm, mid sea in the Indian Ocean, needed only to have their backs scratched to afford the desired Diatomaceous contribution.

The Salpæ, however, were the most prolific, and generally the most abundant, and from their tiny stomachs it was easy to extract a number of novel and most interesting species, including Diatomaceæ, Polycystinæ, and Foraminifera. When of the smallest, they could still be rendered available, for what was deficient in size was made up for in number, and my nets would frequently come up filled with their multitudinous bodies. In this case it was only necessary to crush or rather strain the mass through the material (crinoline by the way) of which the bag was composed, collect the heavier deposit, and treat it in the customary method. Sometimes the Salpæ were from six to ten inches in length, with a digestive apparatus as large as a large marble, and from these a rich harvest was afforded.

During the calms alluded to, I was enabled to observe that, extending for many degrees in the Bay of Bengal and Indian Ocean, the surface of the sea, to a considerable depth, absolutely swarmed with delicate yellow flocculent masses of the genus described by Mr. Brightwell, in the Society's 'Transactions', under Ehrenberg's name of Rhizosolenia. Indeed, I believe I was the first to point out to Mr. Brightwell its filamentous character, and the appearance of its flocculent masses. Near the Equator this organism was accompanied by a Coscinodiscus, the cylinders of which were so large as to be easily distinguishable with the unaided eye from the upper stern ports, whensoever the sun poured down his rays into the clear blue abyss below.

Nor was the Rhizosolenia confined to the eastern side of Africa. To the south of the Cape, and up the Atlantic as far as the Western Islands, it occurred frequently, but only in the Salpæ stomachs—a fact that goes far to show that many minute forms escape observation solely from the tempestuous nature of certain seas; whilst, although not more abundant, in the tranquil latitude of the tropics, or within land-locked seas, they rise towards the surface, and more readily exhibit themselves.

There are certain mysterious influences, atmospheric pro-

bably, apart from the broad distinctions of calm or tempest, which regulate the appearance or disappearance of many of the minute animal organisms from the surface, sometimes at a moment's notice; and I cite the circumstance in order to warn others, who may perchance "go down into the sea in ships," never to lose an opportunity of capturing any creatures that present themselves, however abundant they may appear to be, for whilst one cast of the net may contain a myriad, the next may be drawn blank and unfruitful.

In conclusion I would observe that it is my intention to work out as far as possible the Diatomaceæ and Desmidiaceæ at my command. The other families I shall not venture to approach; but any specimens, drawings, or information it is in my power to supply to those gentlemen who direct their labours towards them, I can only say shall be most cheerfully placed at their disposal.

Note on CAMPYLODISCUS HODGSONII. By G. A. WALKER-ARNOTT, LL.D. Communicated by Mr. F. C. S. ROPER, F.L.S. &c.

(Read April 20th, 1858.)

"ON examining with some attention your slide of *Campylodiscus Hodgsonii* from Lyme Regis, and comparing it with others in my possession, I find—

"1. That your specimen is the same as what I have from the River Orwell, contained in a slide from Professor Smith, named *C. Hodgsonii,* and marked, Collected by J. Hodgson, Esq., August, 1850."

"2. That it is the same as one I have from Carrickfergus.

"3. That it is the same as two frustules I have found in a gathering from Ipswich, obtained several years ago by the late Mr. Wigham, of Norwich.

"4. That it is the same as one frustule (one of four marked ones) contained in a slide from Poole Bay, of September, 1852, from the late Professor Smith.

"5. That it is the same as the *C. eximius* of Dr. Gregory. All these agree with the large state of the species, fig. 53, of Smith's 1st volume.

"I also find that the small state of *C. Hodgsonii* is not well represented in Professor Smith's book, fig. 53 A, there being no moniliform lines, but canaliculi on the central part or disk. This small state I find (from one to three frustules in every

slide) in my Ipswich preparation. Three out of the four marked *C. Hodgsonii,* in Smith's slide from Poole Bay, belong to it. I have seen it also from Arran, and various other parts, so that it is much more common than the large kind, if it can be so called.

"In the large one there are no canaliculi on the disk or central portion, and the granular striæ are often very obscure, particularly after long boiling in acid. Smith's figure shows that they are placed in lines, but this arrangement is often so unsatisfactory in most specimens as to leave a justifiable doubt on Dr. Gregory's mind, if his *C. eximius* could be the same. The small one has the median line (?) sharp; it is scarcely a line, but a strong plica or keel; the canaliculi pass on almost to the middle line, being scarcely fainter on the disk than those of the margin, with which they are continuous and isometrical. The apparent separation between the disk and the margin is caused by a flexure or keel. If we were to suppose *C. Ralfsii* to have a flexure of this kind (to which there is an approach in figs. 52 and 53 of Dr. Gregory's Clyde forms), this small one would through it be more allied to *C. Ralfsii* than to the large *C. Hodgsonii.*

"It thus appears that the *C. eximius,* Greg., is the same as the large *C. Hodgsonii* of Smith, and the small *C. Hodgsonii* cannot be the same species. The large *C. Hodgsonii* is scarcely known, at least by that name; that which is usually so called (and which was probably alone known to Dr. Gregory) is the small one. If Mr. Hodgson had found both, it might suffice to give his name to the small one, and call the large one *C. eximius;* but if he did not find the small one, there would be an absurdity in giving his name to the species not collected by him, in which case this last might be called *C. Smithii.*"

The foregoing extract from a letter received from Professor Walker-Arnott, he has permitted us to bring before this Society. In his conclusion, as to the identity of the large *C. Hodgsonii,* Smith, and the *C. eximius* of Dr. Gregory, I entirely concur. I have specimens of the *C. Hodgsonii* from the River Cleddau, South Wales, from Lyme Regis, Weymouth, and Milford Haven, and find the markings in the central part of the valve in all states, from the distinct moniliform radiant lines, described and figured by Professor Smith, to the faint and irregularly scattered granules, characteristic of *C. eximius,* and in some specimens hardly any discernible at all, with any object glass or variety of illumination. These variations also are not dependent on locality, as they occur in the same gathering, and I think therefore they afford no sufficient grounds for separating two forms that agree so

exactly in all their other characters. The smaller form alluded to by Dr. Arnott appears to have been considered a young state of *C. Hodgsonii* by Professor Smith; but as in addition to the difference of structure already alluded to, I never remember to have seen any valves of an intermediate size, that could serve as connecting lines between them, and though both may be considered among our rarer British species, the smaller one is by far the most abundant, I am inclined to concur in the propriety of giving it a distinct specific name.

On the DIATOMACEÆ *of South Wales.*

By FITZMAURICE OKEDEN, C.E.

(Read June 16th, 1858.)

HAVING read the remarks made in his address by our late president as to the paucity of slides contributed to the cabinet of the Society, I must confess that I feel the justice of them, and the more so as, if I mistake not, the subject has been alluded to by a former president in his address. I have, therefore, ventured to come forward to assist in removing that reproach which our late president considered as resting upon the members from the smallness of their contributions.

During the last five years, while resident at Haverfordwest, in Pembrokeshire, I have employed my leisure hours in studying the Diatomaceæ of the country.

The town itself is situated on the banks of a tidal river, overlooking extensive salt marshes, which are frequently overflowed by spring-tides, and abounding in shallow pools and ditches; not far from it are some large and quiet fish ponds. A few miles to the north, at a place called Churchland, is a large tract of boggy land, at the foot of a mountainous district; mill-streams, over-falls, and weirs, so favorable to Diatomaceous growth, abound in the neighbourhood; while near to Carmarthen is a vast and extensive morass, intersected by ditches, and excavated into pools by the turf-cutters. And lastly, there are the shores of Milford Haven, and the extensive mud-banks of the tidal estuary of Neyland, which latter I have penetrated by boring to a depth of twenty, thirty, and forty feet, and succeeded in obtaining many interesting species at these depths.

The result of a five-years exploration of all these localities has been the collection of upwards of fifty genera, including

above two hundred and thirty species, many of which are either new or interesting varieties of known species, which, from having such an *embarras des richesses,* I have been able to collect a tolerable number of the more known species in a very fair state of purity.

With a very few exceptions, the whole of these genera and species are contained in the accompanying slides which I have now the honour of laying before you, and which I beg the Society to accept, if they think them worth adding to their cabinet. The cabinet in which they are contained is one I designed some time ago for the purposes of travelling, and which I have found extremely convenient, as it holds a large number of slides (228) in a small compass, and requires no packing; the mere shutting of it up keeps every slide in place, while, from their arrangement, every label can be read, and each slide easily got at. Its economy is no small recommendation, the cost being only fifteen shillings.

Accompanying it, I beg to hand in two documents; one is a catalogue of the slides and their contents, the slides being numbered to correspond; the other is an alphabetical catalogue of the genera and species; and opposite each species is the number of the slide in which it is to be found. Where the same species occurs in more than one slide, the best sample of it is shown by underlining the number of the slide in which it occurs.

Where I have thought it necessary, I have mounted a slide dry as well as in balsam; and most of the filamentous species I have mounted so as to show them in their natural state, unboiled in acid. This has been done by burning out the endochrome of the living plant, and then mounting in balsam in the usual way. This will be found a very good plan for these species, and I would cite Nos. 66, 42, 62, and 89, as a sample.

In order to render the habitats more distinct, labels of different colours are used, thus:

Fresh-water	White.
Brackish	Dark yellow.
Marine	Light yellow.
Clay-borings*	Pink.

Of course I am not going to weary you by a recapitulation of the whole of the genera and species in the catalogue, but I would wish to call your attention to a few of those which are of the most interest, as being either new—I mean

* Clay-borings are numbered separately.

genuinely new, and admitted as such into the standard works on the subject—or as being interesting varieties of the more known species; and also to the doubtful forms, the position of which has yet to be determined. Taking them therefore in the order in which the numbers of the slides run, they are as follows:

No. 9. I give this as containing a curiously distorted form of *Surirella biseriata*, having a central construction; this does not appear to me a common variety, as I have only once met with it.

No. 10. I give as being my original gathering of *Surirella apiculata*, first pointed out by me to the late Professor Smith in April, 1854. I have never found it since, and I am inclined to agree with him when he terms it "a close ally, if not a variety, of *S. angusta*." (Page 88, vol. ii, 'Synopsis'.)

Nos. 19 and 19 *a*. This is my original gathering of that curious species *Orthosira mirabilis*, and was first obtained by me at Haverfordwest, in April, 1855. In the April of 1857, I made a second and more copious gathering from the same spot; this will be found in No. 129. It has since been found by Mr. Ralfs and others, in the interstices of the barks of various trees. The Navicula in these gatherings I at first referred to *N. tumida*, but was corrected by the late Professor Smith, who pronounced it to be *N. pusilla*, and in this he is also supported by my kind friend and correspondent Dr. Walker-Arnott, I must, therefore, bow to such authority and name it as *N. pusilla*, but then the characteristic of "brackish" must for the future be omitted in giving the habitat of this species in any specific description, as the locality where this gathering was made was purely a fresh-water one, and totally free from marine or brackish influence.

Nos. 29 and 59. In these two slides will be found a Pinnularia with somewhat constricted ends, which I consider as a variety *P. radiosa*. I see nothing to warrant the erection of them into a new species; I therefore merely point them out as an interesting variety of the above. A reference to the catalogue of the slides will, however, show that the two gatherings are from two widely different localities; thus we may assume that the variety is a well marked one.

No. 35. I merely point this gathering out as being interesting from consisting of *Synedra radians* in a state of congregation, as shown in plate B, vol. 2, of 'Synopsis'; of course the boiling in acid has destroyed the gelatinous envelope, but the bundles still remain perfect.

Nos. 49, 50, 51, 52, and 53. I give these as affording ex-

cellent samples of *Navicula firma,* and its varieties. First in Nos. 50 and 51, we find the true *N. firma,* with the valve truly "elliptical, and slightly attenuated towards the rounded extremities;" next, in No. 53, we have the variety *β,* with the ends "suddenly attenuated;" next, in No. 49, we have the variety *γ* (page 90, vol. ii, 'Synopsis'), with the ends "curvate," a much larger form than any of the preceding, and with coarser; and lastly, in No. 52, we shall find (if carefully looked for) an intermediate variety between *β* and *γ,* namely, one in which the ends are slightly constricted, while the very apices of those ends are cuneate. I may add also, that No. 49 abounds in fine specimens of *Surirella biseriata,* while in No. 53 will be found, though rare, good specimens of Dr. Gregory's *Surirella tenera—S. linearis* of the 'Synopsis'.

No. 67. I give this slide as containing a curious variety of *Diatoma elongatum,* for I can refer it to no other species. I allude to the small form in the slide, the side view of which shows a central inflation; in fact, in outline it much resembles the S.V. of *Navicula inflata,* for which it might be mistaken, did not a careful examination of the slide show the frustules, growing in the zigzag chains, characteristic of the genus Diatoma. I have marked one of these chains with an ink ring, to facilitate the examination of any member interested in the matter. I give this doubtfully as a variety of the above species (*D. elongatum*), for in many respects it must be confessed, it widely differs from the specific description of that species in the 'Synopsis', (see vol. ii, page 40.) The description there given says "Valve linear extremities slightly inflated;" and again, at page 41, in describing the difference between *D. grande* and *D. elongatum,* the author says, "In *D. elongatum* the extremities in the mature valve are absolutely wider than any other portion of the valve." But in the Diatoma under consideration, it is the centre which is inflated and wider than any other portion of the valve. Still I see not sufficient grounds at present for erecting it into a new species, and I therefore leave it for future observers as a (?) variety of *D. elongatum.*

No. 69. I merely draw attention to this as being a fine gathering of *Nitzschia plana,* by no means a common species; *Tryblionella scutellum* also occurs here, though rarely.

No. 85. I would draw attention to this as being a fine gathering of that rare Diatom, *Nitzschia scalaris.* Up to the present time I am not aware of any other habitats for it except Poole Harbour (the original one), and the Haverfordwest Salt Marshes, in which this gathering was made in 1856. Allusion is made to it by the late Professor Smith, in his

paper on the Pyrenean Diatoms, in the 'Magazine of Natural History,' for January, 1857.

No. 92. In this gathering will be found rather plentifully a minute oval form, with median line, which I give doubtfully as (?) *Achnanthidium lineare.* The side views are the most abundant, but a careful examination of the slide will detect the F. views, which exhibit decidedly the geniculate character of the genus. As the present gathering has never been treated with acid, *does* not exhibit stripes, and *did* not do so even when fresh gathered, I place the form in question with the genus *Achnanthidium.* I refer it *doubtfully* to *A. lineare,* because a careful examination will show that it does not entirely agree with the specific description of that specie in the 'Synopsis,' and thus I leave it for other observers.

Nos. 99 and 99*a.* In this gathering will be seen somewhat plentifully a small, elliptical, lanceolate form, with an apparent stauros, but the application of a sufficiently high power will show that there is no true stauros, and that the striæ extend over the whole surface of the valve. It is the *Stauroneis dubia* of Dr. Gregory, and is allied to his *Stauroneis rectangularis* (now *Navicula lævissima* of the 'Synopsis,' vol. ii, p. 91). For the reasons above stated, however, its removal from that genus becomes imperative, and it must follow his *Stauroneis rectangularis* into the genus Navicula. Adopting the suggestion of my friend Dr. Arnott, I propose to name it *Navicular decipiens.*

No. 102. In addition to the *Nitzschia Closterium* in this gathering, will be found a small form which I refer doubtfully to the frustules of a Schizonema. The valve is laurestale, acute on side view, and linear on F. view. When gathered fresh, the frustules were certainly free; yet a peculiar arrangement of them, in which they appear to be congregated into something approaching to a filamentous state, leads me to suppose them to be the produce of a Schizonema, either broken loose or preparing to throw off the mucus which is to form their envelope.

Nos. 104 and 104*a.* In this gathering will be seen two Synedræ, one an extremely long form, with rather coarse striæ, which I refer to *Synedræ longissima;* the other, a shorter and more slender form, with more delicate striæ, I am inclined to refer to *S. radians,* var. γ. A better and purer gathering of the *S. longissima* will be found in No. 146, from Tenby; I think it cannot for a moment be confounded with *S. radians.*

Nos. 107 and 107*a.* Are worth notice for a curious small form of *Pinnularia interrupta,* which is abundant in them.

No. 109. I give this as the true *Cocconema parvum,* not a

common species. When first gathered, the stipes were quite distinct.

No. 114, 114[1], 114*a*, and 114*b*. I give this as *Homœocladia filiformis,* to which species it most nearly approaches; still it differs from that species in one respect, namely, that whereas in the specific description of *N. filiformis* in the 'Synopsis' we find "fascicles containing three or four frustules," while in this specimen the frustules are closely and densely packed in large numbers. A reference to the slide marked 141[1], which contains the Diatom in its natural state of growth, burnt on the cover so as to show the threads, will explain what I refer to. I have put a ring round a well-marked collection of these threads. Nos. 114*a* and 114*b* contain the Diatom boiled in acid for further examination and comparison, and I feel sure that a careful examination of these slides will convince any one that this species is to be referred to *H. filiformis,* and to none other.

Nos. 120 and 120 *a*. This is the gathering of *Achnanthes parvula,* of Kutzing, to which Dr. Arnott alludes in his paper on Rhabdonema.* I found this interesting species in profusion at Neyland, in the March of 1857. I am not aware that it has ever been found by any one before or since in any British locality. It would be presumption in me to add anything to the description given of it by Dr. Arnott.

No. 121. This gathering is interesting, as containing *Nitzschia linearis* in a state of conjugation. I have marked on the slide several bundles of the Nitzschia, which, when the gathering was freshly made, were to be seen surrounded with a mucous envelope, and exactly similar in appearance to the bundles of *Synedra radians* in No. 35. This, therefore, adds one more to the list (at page x. of the introduction to volume ii, of the 'Synopsis') of those species in which conjugation has been observed.

Nos. 121 *a* and 122. These are interesting, as being gatherings of *Amphora minutissima,* perfectly *free* and *non-parasitical.* A reference to the index to the slides will show how widely apart are the localities of the two gatherings; No. 121 *a* being from Neyland, while No. 122 is from the Vale of Neath, near Swansea. This, I think, goes far to prove that *A. minutissima* is not *naturally* a parasitic Diatom.

No. 123. Is my original gathering of *Surirella Amphioxus,*† first pointed out by me to the late Professor Smith, in 1855. I should be glad to know whether other observers have found it.

* 'Micros. Journal,' Jan. 1858, p. 92.

† 'Synopsis,' vol. ii, p. 88.

No. 130. This is the acute variety of *A. longipes* (*A. brevipes* of Kutzing), also noticed by Dr. Arnott, at p. 92 of the June, 1858, number of 'Microscopical Journal.' I have nothing further to add to his excellent description of it. I merely point it out as interesting to the observer.

No. 140. I must call attention to this splendid gathering of *Epithemia Argus*; at least, to this species I refer it. The very conspicuous foramina on the F. V. would lead one to refer it to *E. ocellata*; but the perfectly linear character of the F. V. precludes it from that species. Perhaps it may become a question at some future time, whether *E. Argus* and *E. ocellata* should not be united.

Nos. 141 and 142. This gathering is from the same spot as the last. Here is the *Navicula scita* of Professor Smith's Pyrenean paper. A careful examination of the slide will show a variety of the above having a central inflation.

This concludes all I have to remark on the gatherings of the living plant. I now pass on to the clay boreings, all of which are numbered separately from the other gatherings.

These slides, twelve in number, consist of samples of clay from tidal deposits at various depths, obtained by a special boreing apparatus. A description of the apparatus and mode of using it, and also of the various clays, is given in a short paper of mine, in volume iii, p. 26, of the 'Microscopical Journal;' I need not, therefore, repeat it here.

Nos. 1, 2, and 3, from brickyard, will be found rich in *Triceratium favus* (especially No. 1). In No. 2 will be found a good specimen of *Triceratium armatum,* first found by me in the Neyland mud. I am not aware whether it has occurred to any one else. And, lastly, in Nos. 1, 2, and 3, will be found also beautiful specimens of Mr. Roper's *Actinocyclus sedenarius.*

No. 4. Again, in No. 4, which is a boreing of the Neyland mud, at twenty feet in depth, will be found some fine side views of that fine Diatom, *Biddulphia turgida,* of which I think I may also claim the first discovery.

Nos. 5 and 6. Are also Neyland mud, but from a depth of thirty feet. These contain fine end views of the *Biddulphia turgida.* In all these slides, viz., Nos. 1, 2, 3, 4, 5, and 6, I have marked with an ink ring all the objects of interest, so as to render the reference to them more easy.

Nos. 7, 8, 9, 10, and 11. Are from clays at various depths of fifteen to twenty-five feet, from the bed of the new docks now excavating at Swansea. These are all very rich in *Epithemia musculus,* while in Nos. 8 and 11 will be found good specimens of *Surirella fastuosa.*

My task is now completed. The slides which I have sent will, I think, afford a very good illustration of the Diatomaceæ of this part of Wales. With one exception, that of No. 146, which was from Tenby, and sent me by my friend Mr. Roper; the whole of the gatherings have been made by myself, and I can therefore vouch for their authenticity.

I trust that the little I have done will prove of interest to some of the members of this Society; at any rate, if it only be the means of inciting others to better and more extensive contributions, I shall feel amply repaid for any trouble I may have taken in the matter.

DESCRIPTION *of a* NEW "SECONDARY STAGE." By W. HISLOP, Esq.

(Read June 16th, 1858.)

THE want of some simple and effective means of affixing the various illuminators beneath the stage of the microscope, which shall possess the necessary adjustments for centering and focusing, is felt by every one who makes use of the instrument for purposes beyond those of mere exhibition. Several 'secondary stages' have been constructed, which have more or less answered the requirements of the case, but have also left room for improvement. Most of these arrangements have the disadvantage of weight, an element of inconvenience in the better class of instruments which it is to be hoped has reached its limit. All these various methods, too, require the attachment of the various pieces from the top or bottom, thus increasing the necessary space between the stage and mirror, and risking the derangement of the light, which it is often desirable to retain in precisely the same conditions. In some instruments the adjustments are attached to each piece of apparatus, but this immensely increases the quantity of extraneous mechanism.

The contrivance I have now to submit is one which I have had in use for some months, and which I have found effective and convenient. It possesses the advantage of adaptability to almost every stage; the illuminators can be instantly inserted and removed from the side, and are

adjustable in two directions for centering, and vertically to the stage for focusing.

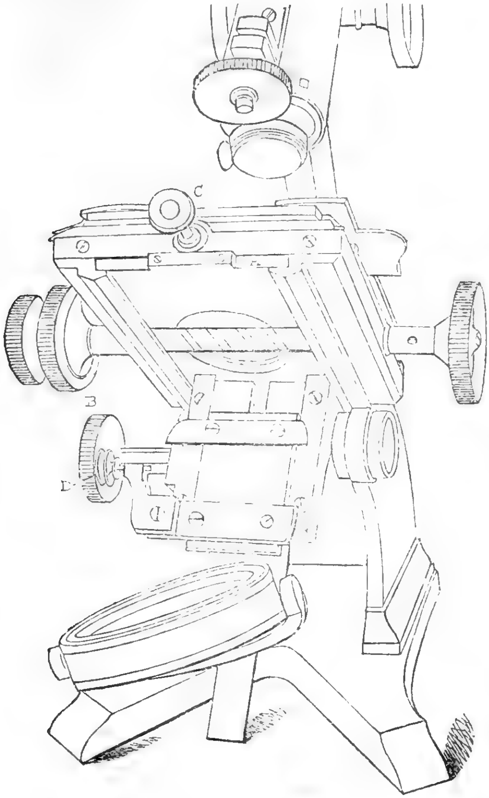


Fig. 1.

Fig. 1 shows the contrivance attached to the instrument, and fig. 2 when separated from it.

It consists of a base plate, A, which slides beneath the stage. A limb is attached at right angles to this plate, which limb is ploughed out for a slide actuated by a rack and pinion, the milled head of which is seen at B. On this slide, and at right angles to "its plane of motion," are affixed a pair of cheeks, between which a smaller slide, carrying the achromatic condenser, Nicol's prism, spotted lens, &c., is inserted. The base plate has an adjusting screw at C, which centres in one direction by bearing against the stage; and at

D is a second adjusting screw, which bears against the slide carrying the illuminating media, and thus gives a second centering adjustment at right angles to the first.

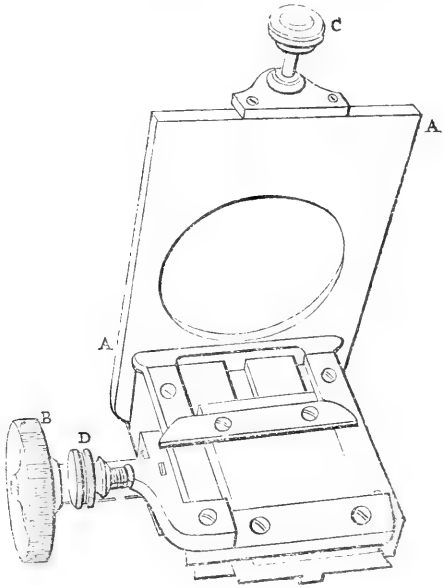


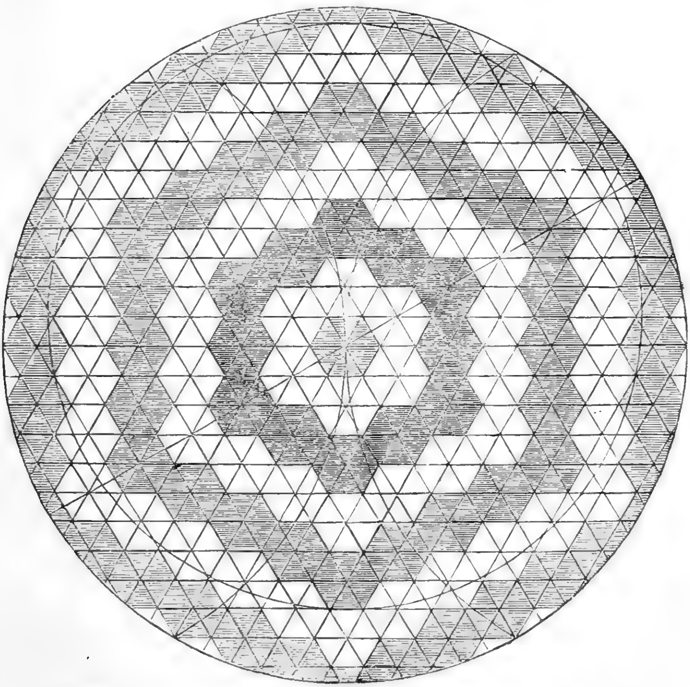
Fig. 2.

INVESTIGATION *of a* SIMPLE RULE *for* FINDING *the* NUMBER *of* ENTIRE HEXAGONAL FACETS *contained in a* GIVEN CIRCLE. By H. M.

I. THE area of a hexagonal facet (the diameter bisecting the sides being $= \delta$) $= \frac{\sqrt{3}}{2}\delta^2 = \delta^2 \times \cdot 866025$.

II. The area of a circle whose diameter $= N\delta$ is $N^2\delta^2 \times \cdot 7854$.

III. Then the number of areas in the circle, each equal to that of a facet, is $\frac{N^2\delta^2 \times \cdot 7854}{\delta^2 \times \cdot 866025} = N^2 \times \cdot 90691 = N^2 \times \cdot 9$ or $\frac{9}{10}N^2$ nearly.



IV. But this does not represent the number of entire facets in the circle, for many of these facets *will be cut through* by the circle, *and the fractional parts must be rejected* (by the question). We must therefore seek a more accurate method of calculation.

V. Take now, as Case I, that *of* N *an odd number,* the centre of the circle containing the facets, coinciding with the centre of one of the facets.

It is evident from fig. 1 that hexagonal facets must be arranged on any surface, *plane or curved,* in the following order:

1st. A facet in the centre.
2d. Six facets round this central one.
3d. Twelve round those.
4th. Eighteen round the last; and so on, increasing by six in each term of the series.

Hence the whole number of facets in the hexagonal arrangement, whose diameter $N = 2n + 1$, may be thus found. Let H be the number required, then $H_1 = 3n \, . \, \overline{n + 1} + 1$.

EXAMPLE.

$$N = 35$$
$$2n = 34$$
$$n = 17$$
$$3n = 51$$
$$n + 1 = 18$$
$$\therefore H_1 = 51 \times 18 + 1 = 919.$$

CASE II.

VI. If N be even, the centre of a circumscribing circle will fall in the bisection (A) of a side of a facet (fig. 2).

Here, therefore, we must find, by the rule for Case I, the number of the facets in the half hexagon whose centre is the centre of the facet next to A (observing that if n be the number of facets in AB, $\overline{n - 1}$ will be the number of terms in the arithmetical series), twice the number so found will be the number in the whole hexagonal arrangement, less by the row of facets on the diameter $AC (= 2n)$.

$$\therefore H_2 = 3n \, . \, \overline{n - 1} + 2n + 1.$$

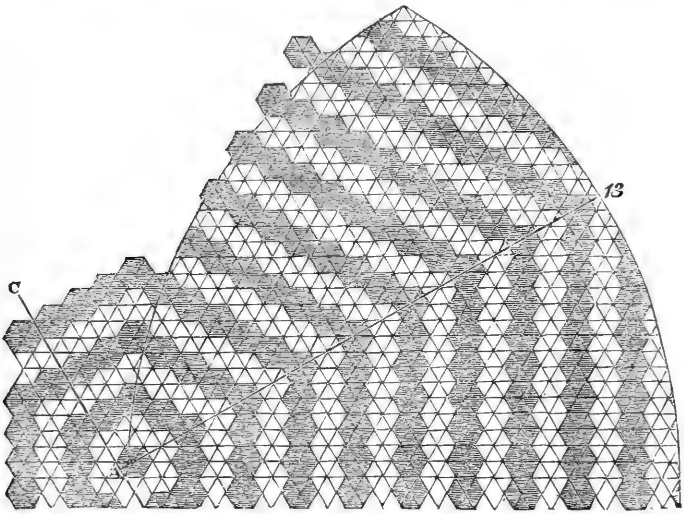
It has now been shown how to find the exact number of

hexagonal facets in a given hexagonal arrangement of the same.

This is a necessary step towards finding the number of such facets contained in a circle described about this hexagonal group.

VII. We know indeed that the number required must be (by § II) *less than* $N^2 \times \cdot 9$ $(= C)$ and *not less than* H_1 or H_2 (or H).

The question therefore is,—Can we find a proportion of the



difference C — H, which being subtracted from C, would give a remainder equal to the number required?

Now proportion, in the case of $N = 164$, is found, viz., by actually calculating all the ordinates in the segment of the circle beyond each side of the hexagonal figure, erected, on the versed sine, at intervals equal to the diameter of a facet, and then finding the number of facets that may be arranged between each pair of ordinates in succession to be so nearly $\frac{1}{4}(C - H)$ that we may well be contented with this *approximate rule* for finding the number (S) of *entire* hexagonal facets contained in the given circle, viz.,

$$S = C - \frac{1}{4}\Big(C - H\Big) = \frac{9}{10}N^2 - \frac{1}{4}\left\{\frac{9}{10}N^2 - H\right\}.$$

EXAMPLE 1.

$$N = 164$$

$$\frac{9}{10}N^2 = 24206$$

$$H = 20091$$

$$C = \frac{9}{10}N^2 - H = 4115$$

$$\frac{1}{4}(C - H)\frac{1}{4}\left(\frac{9}{10}N^2 - H\right) = 1028$$

$$\therefore S = C\frac{1}{4}(C - H) = 24206 - 1028 = 23178.$$

$$S \text{ as found by § (VII)} = 23228.$$

$$\text{Error} = 50.$$

EXAMPLE 2.

$$\begin{array}{r} N = 10 \\ C = 90 \\ H = 71 \\ \hline 4 \mid 19 \\ \hline \end{array}$$

$$\frac{1}{4}(C - H) = 4$$

$$S = H + 4 = 75.$$

Which number *will be found correct* by inspection of fig. 2.

EXAMPLE 3.

$$n + 1 = 35$$

$$n = 34$$

$$3n = 102$$

$$H = 3n \,.\, \overline{n + 1} + 1 = 3571$$

$$C - H = 4284 - 3571 = 713 \therefore \frac{1}{4}(C - H) = 178$$

$$\therefore C - \frac{1}{4}(C - H) = 4284 - 178 = 4106 = S.$$

On Rhabdonema, *and a* New Allied Genus.
By G. A. Walker-Arnott, LL.D.

The late Professor Smith was justly entitled to be placed at the head of those whose attention was directed to the Diatomaceæ. Possessed of excellent instruments, and of a mind clear and discriminating as to what the limits of a genus or species were, he was alone qualified, if he had obtained access to authentic perfect specimens, to correct the unavoidable errors of Kutzing, or extract what is valuable from the chaotic writings of Ehrenberg; the latter of whom, by his figures of numerous forms of which he had only seen very imperfect specimens, unaccompanied by precise, sufficient diagnostical characters, has done more to cumber the science with a load of useless names than can be rectified for many years to come.

So long as Smith survived, I preferred committing my notes to him to dispose of as he thought proper, his sentiments being in accordance with my own,—that it is better not to publish a new species, or give it a name, than to do so from scanty or imperfect materials which leave both genus and species doubtful. Even now I have some hesitation in writing on the subject, as my views are diametrically opposed to those who consider it necessary to give names to forms which, to the eye, appear distinct, but which have not structural differences sufficient for a specific character; and this alone entitles them to be acknowledged or referred to by others.

In the following I shall endeavour to make the characters as clear as possible.

Smith has first correctly defined and explained the structure of *Rhabdonema.* Each frustule of this genus has two *valves* or ends, which are alike, and marked with moniliform striæ; these valves are separated by several *annuli,* which are cellulate; the annuli project into the interior *septa,* which are open in the middle. These septa are sometimes projected from the whole inner surface of the annulus; sometimes from one half only, and consequently do not then pass beyond the central aperture: the first are called opposite, the last alternate, septa; in either case, each septum is supposed to terminate at the middle; they may be entire, or with openings when they are said to be perforate.

As many merely consult figures, it is necessary that I request my readers to keep the above in recollection; or, if they possess Smith's second volume of the 'Synopsis of British

Diatomaceæ,' to peruse what he says, otherwise my present observations may not be understood. It will be also necessary to bear in mind that, in some other genera, as *Achnanthes*, where there is a dissimilarity between the two valves of the frustule, the one next the point of attachment is termed the inferior valve, the other the superior. These terms I shall have occasion to employ.

Having received lately from Professor Harvey, of Dublin, some Algæ of the group called *Corallinaceæ*, from New Zealand, I washed these thoroughly, in case of any diatoms being mixed with the sand and mud that accumulate about such, and obtained a few only; but two interesting and closely allied forms presented themselves, along with several of Kutzing's species of *Grammatophora*, &c. Both had a resemblance to what I have found in the coarse or sandy portions of Ichaboe guano (imported about two years ago), and of which I distributed some slides under the fanciful but only provisional name of *Gephyria*, as I had not then sufficient materials to clear up its affinities. Of the two from New Zealand, one exhibited a side view which somewhat resembled a species of *Surirella*; the second was elliptic-linear (as if one had compressed a ring), and apparently pierced with numerous pentagonal holes in a double row. These markings sometimes extended to the end of the valve, sometimes stopped half way from the middle. There were also two forms of front views, which it was difficult to connect with the side view peculiar to it.

On afterwards examining the Corallines, I detected a small specimen of *Ballia callitricha*, and creeping on *Corallina officinalis* a little piece of *Polyzonia Harveyana*; on both of these I observed a diatom which resembled closely the genus *Rhabdonema*, but of which the thread was composed of not more than three frustules; this, however, might have arisen from the remainder being broken off, although my present impression is that such an appearance was not accidental. From the scantiness of the materials I succeeded in obtaining only a very small preparation of each; and although I kept them separate, still, in consequence of the previous washing along with the Corallines, a few frustules in both instances had been deposited on, or caught by the Alga, on which the other was parasitical. At first, then, I had some doubts if these two were distinct, as, in both, the valves were furnished with costæ; but the front views exhibited a different appearance, from the septa in the one being rudimentary, while in the other those nearest the valves were marked similarly to these, and scarcely distinguishable from them.

Doubts may arise whether what I have described as costæ on the valve, are not strongly developed septa projected by the adjacent annulus and seen through the valve; and this hypothesis would increase the affinity of the first and third species to the second one. But a careful examination of the first species to be described, where observations can be more easily made than on the other two, leads to a contrary opinion: 1st, the striæ are never seen on the valve except between the costæ; on the lower valve they terminate where the costæ terminate: 2d, I have not been able to detach a single valve so as to exhibit striæ without the costæ, or septa without striæ. The two formations are thus dependent on each other, and the one is indissolubly united to the other; whereas in *Rhabdonema* and *Grammatophora* the septa can be separated, leaving the striated valve by itself.

In all the three species the valve varies considerably in form; so that had I not obtained them in a tolerably separate state, I should have been puzzled whether to combine all into one, or to constitute of them many more species than I have proposed. Indeed, when species of the same genus are much mixed and only known from deposits or dredgings, it is quite impossible to draw any satisfactory conclusions.

Perhaps it might have been sufficient to unite the species I have to notice to *Rhabdonema*; but the valves are not only furnished with costæ, but these costæ are differently arranged on the two valves; whereas in all true species of *Rhabdonema*, the two valves are precisely similar to each other, and without costæ. If the two genera be combined, the character must be enlarged, and then it will be no easy matter to exclude by it other genera which all agree are distinct. I have therefore thought it preferable to separate the new one under the name of

EUPLEURIA.

Filaments compressed or arcuate, continuous, attached. Frustules annulate, indefinite; annuli plane, cellulate or striate on their circumference; septa opposite or alternate, rudimentary or perforate. Valves ovate, elliptical, or arcuate, with one median and several lateral costæ; inferior with the costæ and striæ disappearing below the extremities of the valve, superior with them reaching to the extremity: striæ moniliform, oblique.

1. *Eu. pulchella*; annuli as broad as the flat valves, cellulate; septa all rudimentary.

Hab. New Zealand, on *Polyzonia Harveyana*.

Annuli numerous, about 11 in ·001, with about 15 cells in ·001. Septa apparently wanting, but from the external appearance of the frustule, they seem to exist, although in a very rudimentary state, and to be alternate; they have consequently no perforations. Valves the breadth of the annuli, flat, usually more or less ovate and acuminate, sometimes linear-oblong. Striæ only between the costæ, oblique, about 30 in ·001, easily seen with a quarter-inch object-glass.

2. *Eu. ocellata;* annuli as broad as the nearly flat valves, finely striate; the septa contiguous to the valves, perforate.

Hab. New Zealand, on *Ballia callitricha.*

Annuli numerous, about 13 in ·001, with about 40 striæ in ·001. Septa opposite, those nearest the valves composed of costæ similar to what are seen on the valves, but with the interstices open; the rays on the front view (formed by the subjacent septa) diverging from the lower valve, and converging from the upper one, indicate that these openings enlarge, while the septa themselves become narrower and fainter as they approach the middle of the frustule, where they are evanescent or rudimentary. All the annuli do not project the septa simultaneously; those next the valves do so first, the last projected being the most remote: a frustule, therefore, may present itself which has only the annulus next the valve provided with septa, and one solitary example occurred where even then they had not been formed or were wanting; when this takes place, the species can scarcely be distinguished from the following one, except by the flatness of the valve, the coarser striæ on the annuli, and the breadth of the annuli as compared with the valve. Válves nearly flat, not perceptibly broader than the annuli, elliptic linear or sometimes slightly lunate, rounded at each extremity. The striæ are so faint that I have not been able to observe them satisfactorily.

Mixed with this, and parasitical along with it, are several frustules of what at first sight resembles a minute *Himantidium;* but I have not yet ascertained its side view, and as its genus is as yet doubtful, it is unnecessary to allude to it further.

3. *Eu. incurvata;* annuli conspicuously narrower than the very convex valves, delicately striate; septa entire.

Hab. West coast of Africa (among guano from Ichaboe, 1855).*

* I would not have introduced this species had I not seen many front as well as side views of it, as it is seldom that any certain conclusion can be obtained from deposits, dredgings, or guanoes. As an instance of a mistake occurring in that way, I may allude to *Pleurosigma compactum,* Grev.,

Annuli few, about 5 in ·001, with about 50 striæ in ·001. Septa apparently opposite and rudimentary, or if present are not marked by costæ or perforations. Valves very convex, arcuate, or somewhat linear and lunate, considerably broader than the annuli, the entire frustule presenting the appearance of a little bridge (*Gephyria*) with a low parapet on each side. Striæ oblique, only between the costæ, very much fainter than in *Eu. pulchella*, but not seemingly much more numerous (from 36 to 40 in ·001), although requiring careful illumination and an object-glass of high power ($\frac{1}{8}$-inch) to exhibit them.

In all these the median line or costa is not quite straight, but slightly bent in a zigzag manner, the lateral ones being generally alternate and proceeding from the angles of the median one. In the inferior valve the median line projects slightly beyond the lateral ones, and there usually forms a little knob.

I have not attempted to measure the distances of the striæ or annuli with accuracy; the numbers I have assigned are therefore more to be considered as relative, and probably are very different from what others may determine them to be.

I shall now give the generic character of *Rhabdonema* slightly restricted from what is given by Smith, with abridged characters of all the known species.

Rhabdonema, *Kutz.*

Filaments compressed, continuous, attached, or stipitate. Frustules annulate, indefinite; annuli plane, cellulate on their circumference; septa opposite or alternate. Valves similar,

which is a genuine species of *Amphiprora*. This was first found copiously in the living state, and properly understood by Mr. Ralfs, of Penzance; and as the specific name given by Dr. Greville is quite inapplicable to an *Amphiprora*, I have no hesitation in changing it to *A. Ralfsii*.

A. Ralfsii; F. V. narrow, elliptical, deeply constricted; V. twisted equally from end to end; striæ about 53 in ·001.—*A. didyma*, Sm. Brit. Diat., t. 15, f. 125? (excl. the name and char.)—*Pleur. compactum*, Grev., M. J. V., t. 3, f. 9 (name and char. erroneous).

Hab. Penzance; *J. Ralfs.* Cumbrae; *R. Hennedy.* Dredged also in various places in the Clyde by Mr. Hennedy and Rev. Mr. Miles.

The figure given by Smith is equally characteristic of this species, and of what Dr. Gregory calls *A. Lepidoptera*; but if the number of striæ, 72 in ·001, be not an error of the press for 52, it can be neither. Dr. Greville describes the striæ as "obscure," which they are under a bad object-glass; but they are as conspicuous and as few in ·001 as in *Pleur. Æstuarii*, which usually in this country accompanies it, both in the normal and distorted shells; the latter of which has both ends bent in the same direction, a structure that occurs in some other species of that genius.

elliptical, ecostate, with a median line, striate. Striæ transverse, moniliform.

SECT. I. *Septa entire.*

1. *Rh. arcuatum,* Kutz.; septa opposite; striæ not reaching to the end of the valves.

Hab. Shores of Europe, Africa, and North America.

To this belongs *Tessella catena* of Ehrenberg.

2. *Rh. minutum,* Kutz.; septa alternate; striæ reaching to the extremities of the valves.

Hab. Shores of Europe and North America.

To this belongs *Tessella catena* of Ralfs.

SECT. II. *Septa alternate, with perforations along the middle between the margin and central aperture.*

3. *Rh. Adriaticum,* Kutz.; septa with one oval perforation.

Hab. Shores of Europe, North America, Asia Minor, Mauritius, and Ceylon.

Probably more diffused than any other species. To it belongs *Tessella catena* of Bailey.

4. *Rh. mirificum,* W. Sm.; septa with several (3 to 12) irregular perforations.

Hab. Shores of Ceylon and Mauritius.

In this species the openings in the septa are irregular in form, and reach from the upper to the lower margin of the annulus; while the portions of the septa that separate these are narrow, and resemble bars which are either straight across or slightly oblique. When two such septa cohere, the perforations seem to extend from the one end to the other, and are then in no instance, as far as I have seen, fewer than seven, including the central opening, but usually are much more numerous (20 to 25).

In my preliminary remarks I have alluded to *Achnanthes*. I may here take this opportunity of stating that *A. brevipes* of Kutzing, which has a rather short stipes and valves with acute extremities, has been found lately (November, 1857), by Mr. Okeden, at Neyland, in South Wales. This is referred by Smith to *A. longipes,* on account of the presence of costæ on the valves, along with moniliform striæ: to this there is no valid objection; but, in that case, it ought to be noticed as a well-marked *variety,* and the word "obtuse," in reference to the valves, deleted from the specific character, as by no means applicable to this form of the species. Mr. Okeden has also found (March, 1857) at Neyland the *A. parvula* of Kutzing! a species which must be removed from

the section in which Kutzing has placed it (from using an inferior microscope), as the striæ are very conspicuous with a good lens, being as few as 33 or 34 in ·001. It differs from the true *A. brevipes* of Agardh, by the elliptic-oblong obtuse valves; from *A. subsessilis* by the usually numerous frustules and the distinct and somewhat elongated stipes; and from both by the much finer striæ.

Remarks *on the* Genus "Rhizosolenia" *of* Ehrenberg. By Thomas Brightwell, Esq., F.L.S., Norwich.

Among the remarkable forms lately detected in *Ascidiæ* and *Noctilucæ,* specimens have been found of some which appear to belong to the genus *Rhizosolenia,* of Ehrenberg.

Having had, in this case, as in that of *Chætoceros,* an opportunity of examining the species in a tolerably perfect state, we hope to be able to exhibit the true character of several more of those fragmentary and unsatisfactory forms which Ehrenberg, in his various works, and particularly his 'Microgeologie,' has, as we conceive, too hastily and injuriously to science, erected into genera and species.

The characters given by him of the genus *Rhizosolenia* are "lorica tubular, with one extremity rounded and closed, while the other is attenuate and multifid, as if terminating in little roots." He describes five species, some of which do not at all agree with the above characters; and the late Professor Bailey added a sixth under the name of *R. hebetata.* The greater part of these supposed species are, as we believe, only fragments of the silicious organisms we are about to describe, or of kindred species, and to enable the reader to judge of the correctness of our views, we have given copies of several of Ehrenberg's published figures, as well as figures of all our newly-discovered perfect forms.

Ehrenberg's five species are*

1. *Rh. Americana,* from Virginian earth. Of this he gives no less than eleven figures, most of them certainly not belonging to this genus.

* These species (and a sixth clearly not belonging to it) are described in Kutzing's 'Species Algarum,' p. 24, where the references to Ehrenberg's works or papers, in which they first appeared, are to be found.

2. *Rh. pileolus.* A doubtful species.

3. *Rh. campana,* Bermuda. No figure is given of this; but from the description it appears to be a terminal section of a Rhizosolenia.

4. *Rh. calyptra,* South Sea. This is clearly the calyptriform terminal process of a Rhizosolenia, very like our *Rh. styliformis.*

5. *Rh. ornithoglossa.* The terminal process of the same species. Of Bailey's *Rh. hebetata* we were favoured with specimens by the late lamented professor. It is clearly distinct from any of the above, and from any of our species.

We present the following as a synopsis of the species which have come under our observation.

RHIZOSOLENIA.

Filamentous, frustules subcylindrical, greatly elongated, silicious, marked by transverse lines, extremities calyptriform, pointed with a bristle.

Species.

1. *Rh. styliformis.*—Frustules from six to twenty times longer than broad; transverse lines obvious; terminal process at the base spathulate and bifid; straw colour to chestnut brown.

"Found in the stomach of an Ascidia taken from oyster shells, dredged twenty or thirty miles from the Yorkshire coast, at a place a little to the north of the Humber, known as the 'Silver Pit'" (Mr. Norman, of Hull, in 'Annals Nat. Hist.,' vol. xx, p. 158). In Noctilucæ, Gorleston, Suffolk. (Col. Baddeley.) In guano, Callao, often in little bundles of fragments. In Salpæ. (Dr. Wallick).

The base of the calyptriform process is carried out into a spatula-formed elongation, bifid at the end; the lines of the bifid division run upward on either side, with a stout nerve, to nearly the apex of the cone. Boiled in acid, the frustules break up, and the calyptriform processes in an isolated but perfect state, and detached imperfect rings are only to be found. (Pl. V, fig. 5.)

2. *Rh. imbricata.*—Frustules four to seven times longer than broad, punctated; terminal process subulate, entire; pale straw colour.

In Ascidiæ with the former. (Mr. Norman.) In Noctilucæ. (Col. Baddeley.)

The direction of the transverse lines and puncta give this species an imbricated appearance. (Pl. V. fig. 6.)

3. *Rh. setigera.*— Frustule five to fifteen times longer than broad; transverse lines obscure; terminal bristle as long as the frustule; colourless, of glassy transparency.

In Ascidiæ with the two former species. (Mr. Norman.) In Noctilucæ. (Col. Baddeley.) In Salpæ. (Dr. Wallick.)

This species is distinguished by its extreme delicacy, and by the great length of the terminal bristle. (Pl. V, fig. 7).

4. *Rh. alata.*—Terminal process alate, recurved, blunt; colour chestnut brown.

In Ascidiæ with *Rh. styliformis.* (Mr. Norman.)

This delicate little species, which bears some resemblance to a pipe fish, and might have been called "sygnathoides" differs from all the others by its blunt, turned-up nose, and its small but conspicuous appendages to the terminal process (Pl. V, fig. 8).

In most of the above species, self-division has been observed. It takes place in or near the centre of the frustule, and has the same indefinite character as in Rhabdonema and Striatella. The rings of the Rhizosoleniæ appear equivalent to the annuli in these genera, but, instead of being perfect and united by flat surfaces, they are united at acute angles, and carry out the frustule to an almost indefinite length. The process of self-division is therefore truly diatomaceous. Two new calyptriform valves are gradually formed within a connecting membrane, as is seen in our Pl. V, figs. 6, 7, *a*, *b*. These eventually separate, when the old frustule becomes two, each division having a new calyptriform end.

In the genus Isthmia, the frustules of which are trapezoidal, one valve having a produced angle, we see some resemblance to the Rhizosoleniæ, and this would be much increased by supposing an Isthmia carried out to ten times its normal length, and self-division taking place in the centre, as seen in the central fig. in pl. xlviii, 'Smith's Brit. Diatom.'

In specimens of *Rh. setigera* a motion has been observed resembling that of many of the Diatomaceæ, the frustule proceeding forward in a jerking, tremulous manner, and then retrograding.

Large numbers of *Rhizosolenia* have been detected in the stomachs of Salpæ, and they have also been observed floating free in the ocean in warm latitudes, their appearance being that of little confervoid flakes of exquisite delicacy, but of a sufficient aggregation of filaments to be seen by the naked eye. The mass appeared (probably from the endochrome) of a faint, evanescent, ochraceous colour.

FLUSTRELLA HISPIDA *and its* DEVELOPMENT. By PETER REDFERN, M.D. Lond., Lecturer on Anatomy and Physiology, and on Histology, in the University and King's College, Aberdeen.

(Read before the Natural History Section of the British Association, at Dublin, in August, 1857.)

THE *Flustrella hispida* of Dr. Gray is the *Flustra hispida* of Fleming, and the *Flustra carnosa* of Dalyell and Johnston. It seems to have been overlooked by Mr. Gosse, in his 'Marine Zoology,' and to have attracted much less attention than it deserves, when its beauty and general distribution are considered.

I have found it abundant on the rocky coast of Kincardineshire, for eleven miles south from Aberdeen; on the Irish coast at Howth, Dalkey, and Bray, in the Bay of Dublin, and at Wicklow; also in North Wales, at Llandudno. It usually grows on the fronds of *Fucus serratus*, but in the immediate vicinity of Aberdeen, it is excessively rare on that Fucus, but abundant on *Chondrus mamillosus*. It forms round or oblong, brown, hairy patches, about a line thick, which extend completely round narrow fronds, but are confined to one side of broad ones. It is invariably encrusting. The extent of the cœnœcium rarely exceeds an inch on the Kincardineshire specimens, but it extends for three or four inches on those gathered in Dublin Bay and North Wales. It occurs on the Fucus, together with the *Alcyonidium hexagonum* (Hinks) and the *Cycloum papillosum* (Hassall); on the specimens of Chondrus the *Flustrella* occurs with *Alcyonidium hirsutum*.

The cœnœcium is thick in the centre; thin, and composed of the last-formed individuals at the edges. The cells radiate from the centre, and they are imbricated in various degrees in different parts, the whole length of the cell, or merely its summit, being visible on the surface. The arrangement of the cells is variable, but generally alternating. When allowed to dry on the plant, the cœnœcium presents the appearance of a wrinkled, hairy membrane; when it is sliced from the plant, and dissected with needles, a large quantity of viscid matter escapes from its cells.

The wall of each cell is set with rigid, reddish-brown, pointed and slightly curved hairs, very numerous, and, for the most part, occupying the whole circumference in the Kincardineshire specimens, but very few in number, and set

in a semicircle over the summit of the cells, in the specimens from Dublin, Wicklow, and North Wales.

In the Kincardineshire specimens, the young cells have five to seven or nine hairs in a semicircle over their summits, and two or three only on each side. The older cells have hairs distributed uniformly over their whole circumference, their lateral septa often presenting eight to twelve or more hairs with their roots closely packed together, one half having their points directed over the cell to the right of the group, the other half having theirs turned over that to its left. One of the lateral hairs on each side often reaches across the cell at the lower margin of its aperture, but no hair of any kind grows in any other position than those above indicated.*

In the specimens from the Irish and Welsh coasts, the summit of the cell has often no more than three hairs upon it, the usual number being five to seven; the sides and base of the cells are often entirely devoid of hairs, the lateral septa occasionally presenting a patch of two or three. So far as I am able to judge from the examination of a large number of specimens, there is always a wide difference in the number of hairs on the Kincardineshire specimens and those gathered further south, this difference being the more remarkable, because an inverse ratio maintains between the number of hairs and the extent of the cœnœcium in the two series of specimens. I am anxious that the attention of naturalists should be directed to this occurrence, because it is possible that the functions of the hairs may be determined by observations of the number and character of the hairs of the same species, growing under different circumstances.

The aperture of the cell is somewhat quadrangular—distinctly so during the protrusion of the polypide. The characters of the cells, their hair sand apertures, are shown in Pl. IV, figs. 1, 2, 3, and 3 *bis*.†

The polypide, when healthy, is easily removed from the cell with its digestive viscera entire, as in fig. 4. The number of tentacles I found to be twenty-eight in all but one of a large number of instances, in which I counted them with

* In old and much imbricated specimens the hairs on the sides and base of the cells are best shown by slicing the cœnœcium from the plant, and dissecting the cells asunder by needles. By this method the polypide may also be easily removed from its cell in so perfect a state that it will live for many hours, showing the effects of ciliary motion more beautifully perhaps than in any other instance whatever.

† The subsequent observations were all made on Kincardineshire specimens.

great care, by the aid of the camera lucida; in the single instance there were twenty-seven. Each tentacle is hollow, covered by a thick layer of ciliated epithelium, easily detached. It is quite remarkable how rapidly these epithelial cells become distended and destroyed when fresh water is added; and as this is the case also with the cells of other parts of the animal, it is not surprising that fresh water instantly destroys it. Fig. 5 represents a portion of a tentacle with its epithelium in the natural state; fig. 6 the tentacle divested of its epithelial covering; and fig. 7 shows the action of fresh water upon the epithelial cells.

The pharynx and œsophagus are lined throughout by ciliated and columnar epithelium. The stomach is separated from the œsophagus by a distinct and complete valve which never allows the alimentary matters to regurgitate. The œsophageal portion of the organ is cylindriform, the body is greatly dilated having a pouch-like dilatation on its great curvature, and being gradually narrowed towards the pyloric aperture, where the stomach can be shut off from the intestine, apparently by a contraction of its muscular wall (pyloric valve). Over the whole of the stomach, the epithelial cells contain a nucleus and deep-red, granular contents. Those of the cul-de-sac, and in the great curvature, and those at the pyloric end, are ciliated; but no cilia are observable in the other parts, nor in any portion of the intestine. The action of the cilia of the stomach is remarkably beautiful when viewed under the microscope, and produces a rapid rotatory motion of the contents of the cul-de-sac, or of the pyloric end, in the axis of these parts respectively.

To the stomach succeeds a dilated portion of the intestine, where the alimentary matters are retained for some time, and converted into elongated consistent pellets. The wall of this portion of the canal has an epithelium, the cells of which contain deep-red granules like those in the stomach-cells, but much fewer in number. Beyond this the intestine is considerably contracted, and its wall becomes so thin that it is often torn during the dissection, in tearing away the tubular sheath of the tentacles, formed of the soft, protrusible portion of the cell. Through this membrane the anus opens externally. I have never noticed the discharge of alimentary matters, except at the moment of protrusion of the tentacles, when the pellet to be discharged escapes from within the crown of tentacles, and commonly falls through between two of them to the exterior.

Muscular system.—The retractor muscular fibres are best seen, *in situ,* in preparations which have been preserved in

spirit, in which they are remarkably distinct. The insertion of the great retractor into the lophophore, the pharynx, and œsophagus, is beautifully seen in the animal removed from its cell by dissection, as in fig. 4.

The great retractor muscle consists of a long cylindriform bundle of fibres, stretching from the deepest part of the cell over the stomach, to reach the œsophagus, pharynx, and lophophore, into which the fibres are inserted. Another bundle of much shorter fibres extends from the side of the cell, near its bottom, to the cul-de-sac of the stomach, into which it appears to be inserted, drawing this part of the organ downwards and towards one side when in action, and thus assisting in folding the parts of the alimentary canal upon each other, that they may be easily accommodated in the interior of the cell. Yet neither these fibres nor any of those of the great retractor muscle remain attached to the stomach of the polypide withdrawn from its cell. I have examined the perfect stomach thus removed in at least twenty instances, and in none have I seen a single fibre attached to the wall of the stomach, whilst, in every case, the torn pharyngeal fibres remain connected with it. Four or five distinct bundles of muscular fibre stretch from the interior of the cell, at different points, to the polypide; passing transversely to the axis of the cell. Other bundles of at least two different muscles extend from the upper part of the interior of the cell to the invaginated portion, which forms the sheath of the tentacles during the retraction of the polypide. The longer of these bundles is so much relaxed during complete retraction, that it is bent upon itself.

During retraction, the œsophageal end of the stomach is rapidly drawn down to the bottom of the cell on one side, the cul-de-sac of the organ to the bottom on the other side; the pyloric end of the stomach is folded upon the upper curvature, the pyloric orifice being brought very close to the œsophageal; the intestine is bent upon the pyloric end until the two lie parallel; and the tentacles are folded in a somewhat spiral manner, close to the intestine which lies by their side. Thus the œsophageal and pyloric ends of the stomach, and the dilated commencement of the intestine, are folded and lie parallel to each other directly across the axis of the cell, in the state of retraction, whilst they lie with their axes parallel to that of the cell, in the state of protrusion of the polypide. The act of retraction is sudden and rapidly completed, like that of voluntary muscles in general; the act of protrusion is performed very slowly, as if the tenta-

cles were gradually distended with fluid, and the body slowly pressed out of the cavity of the cell.

By dissection, ova or statoblasts are obtained in great numbers, presenting the appearances represented in figs. 8 and 10, and consisting of an outer envelope, containing a number of clear and highly refractive nucleated cells, and an opaque, reddish, spherical mass, composed of cells with red granular contents. When some of the contents of these bodies have escaped, their structure is much more easily examined, as in fig. 9. None of those figured possessed cilia. The cilia belong to a membrane, which is placed outside the two capsules figured, and separated from the outer of these by a finely granular mass. Only one of these bodies was observed to have cilia, amongst twenty or thirty carefully examined to determine their presence or absence.

Development.—My reasons for believing that the animal whose development has been examined is the same as the one just described are:—1st, that it grew on the wall of an aquarium, in which there were numbers of specimens of *Flustrella* growing on *Chondrus mamillosus*, and, so far as I could judge, no other which could be mistaken for it; 2d, that on the cell of the second polypide hairs grew of a similar character to those shown in figs. 1, 2, and 3; 3d, the character of the tentacular crown, and the number of the tentacles, as far as it could be determined in a bad position for counting them, and the appearance of the digestive organs, were exactly such as occurred in the creature figured from 1 to 10.

On the 3d of July, 1857, I first observed a solitary polypide in its cell, on the wall of an aquarium. It was apparently in perfect health, alternately protruding and withdrawing its beautiful, bell-shaped crown of tentacles. The elegance of the form of the bell, and the number of its tentacles, led me to compare it with the specimens growing on Chondrus in the same vessel, and the result was, that I could find no difference between them. On this occasion I did not notice any projection of the wall of the cell for the formation of a gemma.

On the 4th of July, a definite projection of the wall was observed (fig. 11); two days later the projection had increased in size considerably, and it presented externally a protruded portion of the wall of the original cell, and in its interior a striation slightly radiating towards the surface, the striæ being produced of rows of highly refractive globules (fig. 21.) On the evening of this second day, the body of the polypide was visible, as a small cone, at the deepest part of the

striated mass, and on the third day it had become much more distinct, whilst the gemma appeared to be encroaching on the old cell, and the striated mass had approached the surface (fig. 13). With a view of facilitating the examination, a small mirror, the framework of which had been recently coated with gold size, was introduced into the aquarium. Shortly afterwards, the tentacles of the polypide (fig. 11) were observed to be bent at various angles, and to hang loosely, as if they had been broken, resuming their natural appearance at intervals. The polypide protruded itself but rarely, and never recovered its healthy characters, dying four days subsequently. I believe that it was injured by the gold size.

On the fourth day of the formation of the gemma, it presented a yellowish striated band at its deepest part, apparently the first trace of its retractor muscle. On the same day, traces of the formation of three other gemmæ were seen, as in fig. 14, but their development was speedily arrested, and they were not again observed.

On the seventh day, the new polypide presented the form of a bent tube, the striation near the surface remained, and between it and the bent canal, representing the body of the animal, there was a clear space faintly separated into bands by indistinct striæ (fig. 15). These ultimately became the tentacles. On this day, four distinct and blunt hairs were observed to have formed on the wall of the cell of the new polypide.

On the eleventh day, the gemma had considerably increased in size, and presented a nipple-like membranous prominence. The polypide was observed shrinking in its cell on the application of a bright light. The hairs, which were blunt at their ends on the seventh day, had become pointed. The perigastric space was quite distinct. The refractive globules, producing the striation near the surface had gradually diminished in number, and formed a thin layer between the tentacles and the surface. This state was figured on the twelfth day, as in fig. 16.

On the thirteenth day, the apex of the cell had become much thinner, and presented the appearances represented in the drawings (figs. 17 and 18), sketched by the aid of the camera lucida, when the polypide was retracted and protruded. The tentacles were much longer and more distinct, the rows of highly refractive globules between the tentacles and the surface were greatly diminished in number and size, and the perigastric space was clearer. The condition of the polypide at this timeis so graphically described by the Rev. T. Hincks,

in a paper in the eighth volume of the 'Annals and Magazine of Natural History,' that I can add nothing to his account of it. I regret that I was not aware of the existence of this paper until after my opportunity of observing the creature had passed away. Mr. Hincks says:—"Imperceptibly the body of the polype shapes itself within the mass. The tentacles are first visible.* Soon violent convulsive movements are seen within. The front part of the cell is frequently pushed out with much apparent force, so as to form a neck of considerable length, and then suddenly retracted. There is no appearance of an opening at this time. The tentacles become very restless, and bend themselves about as if trying their powers, and impatient of confinement. Gradually the parts become more defined; the elongation and retraction of the fore part of the cell continue, and, at length, the polype breaks from its captivity."

On the fifteenth day, the polypide protruded fully, and its tentacles expanded freely. The wall of its cell was beautifully transparent, and admitted a full examination of the viscera, now receiving the alimentary matters. On the seventeenth day, the drawings 19 and 20 were made. In the state of protrusion, the lophophore and anus were carried outwards, and the alimentary canal stretched, owing to the stomach being drawn but little away from the bottom of the cell, whilst the other parts were shifted extensively. Ciliary motion was distinct on all the parts on which it is observed on the adult polypide. In the state of retraction, the quadrangular state of the aperture of the cell was distinctly observed; the tentacles were folded somewhat spirally upon each other; the œsophageal end of the stomach was drawn down to the bottom and side of the cell, and the pyloric end folded over it, the pyloric orifice being carried towards the same side, together with the dilated commencement of the intestine, which was laid parallel to the pyloric end of the stomach, and directly across the direction of the cell.

Some appearance of the formation of a gemma occurred on the wall of this second cell, as in fig. 20, but it became no further developed, and the second polypide itself was found dead on the twenty-seventh day of its existence, to my very great regret.

* When I first saw the striated mass beneath the surface of the gemma I supposed that it was the early stage of the formation of the tentacles, but I subsequently found that they formed beneath it, and that they were not distinct until after the body of the polypide had assumed the decided form of a bent tube.

TRANSLATIONS.

Abstract of Remarks *on the* Marginal Bodies *of the* Medusæ. By Professor C. Gegenbaur.

(Müller's 'Archiv,' 1856, p. 230.)

"These bodies," the author observes, "afford better systematic characters for the classification of these animals than can be derived from the form of their bodies or the relations of their tentacles."

He describes:—*A.* Marginal corpuscles of the lower Medusæ.

This class includes the forms termed by Forbes "naked-eyed," embracing the Æquoridæ, Æginidæ, &c., all probably medusoid forms of polypes. In these Medusæ two kinds of marginal bodies are met with. Both are placed at the border of the disc, and are either in intimate relation with the base of the tentacles, or constitute small eminences between those organs,—in one case supported on long peduncles. One form presents the appearance of vesicles containing earthy concretions, whilst the other represents merely a deposit of colouring matter, sometimes enclosing a refractive body.

a. Vesicular marginal bodies.

These are found, *first,* in all the Geryonidæ and Æginidæ—probably also in the Æquoridæ; and *secondly* in some of the medusoid forms at present included under the genus *Thaumantias.*

In all the true Oceanidæ, as well as in the Thaumantiadæ—both of which families appear to be characterised by the presence of pigment-spots at the base of the tentacles—no trace of vesicular marginal bodies is found to exist.

The vesicles are of a rounded, elliptical or elongated shape, and always have thin walls, apparently continuous with the integument of the *Medusa,* and enclosing the cavity on all sides. Internally this wall is lined with an epithelium, composed of smooth polygonal cells, which are not visible, however, except upon the addition of acetic acid. The vesicle contains one or several spherical or oval, motionless concretions, surrounded with a transparent fluid. The concretions, to judge from the effect upon them of acetic acid, consist in part of carbonate of lime; and after this is dissolved, an

organic residue is left retaining the original form of the concretion. Gegenbaur has never observed crystalline forms or crystals.

The number of these marginal vesicles is constant in the Geryonidæ, and also in the minute medusoid forms resembling *Thaumantias*, and which should probably form a distinct family from the true Thaumantiadæ. In the Æginidæ their number is very variable, and in this group the maximum in this respect is probably reached, viz., about 60; though even in this family exceptions exist.

The position of these bodies always indicates an intimate relation to the gastro-vascular system, although the cavity of the vesicles does not, as might be supposed, communicate with the interior of the gastric canals. This relation is especially evident in the Cuninidæ, in which the marginal vesicles are always situated at the extremities of the gastric sac, and never in the interspaces.

In the Geryonidæ a marginal vesicle is seated at the base of each tentacle. In some species of the family Æginidæ the vesicle is seated in a depression at the summit of a conical eminence, composed of distinct cells, each of which, in a form allied to *Ægina*, supports a long descending *cilium*.

Gegenbaur has never witnessed ciliary movement within the vesicles, nor in fact motion of any kind, except what might be referred to endosmotic action. In this he agrees, he says, with all his predecessors, except Kölliker, who describes in a species of *Oceania* the existence of cilia in the marginal bodies,—an observation the correctness of which Gegenbaur does not doubt, but supposes it to refer to *Oceania marsupialis* (*Carybdea marsupialis*, Peron), whose marginal bodies present very remarkable peculiarities, which he afterwards discusses.

If the rather large marginal vesicles of Geryonia be examined, it will at once be seen that the concretion is not free in the vesicle, but connected to the wall by means of a short peduncle, from which, in fact, a delicate membrane extends over and encloses the concretion entirely. Repeated observation will occasionally detect a much thicker investment, within which, besides the concretion, are contained minute molecules, and an oval or rounded corpuscle, resembling a *nucleus*. In fact, there is nothing opposed to the notion that the concretion is formed in the secreting cavity of a parietal cell which projects into the interior of the vesicle, in the same way that other concretions are formed in the lower animals, as for instance the renal concretions of the Gasteropoda, &c.

If this be the true state of things, there can be no question as to the non-existence of motion in the concretions, and in great measure the analogy fails, which would place the marginal bodies of the Medusæ in the same category with the auditory organs of the Acephala and Cephalopoda.

b. Pigment-spots (*ocelli*).

Coloured spots on the base of the tentacles occur only in the Oceanidæ and Thaumantiadæ, both of which families (certainly the former) are medusoid forms of polypes. Consequently, except in *Oceania turrita,* coloured spots and marginal vesicles are not found to coexist.

The spots themselves consist of dense agglomerations of yellow, red, brownish-red, or black pigment-cells, placed upon a more or less prominent elevation on the base of the tentacle. Except in *Tiaropsis,* their number corresponds with that of the tentacles.

In *Lizzia, Bougainvillea,*—Oceanidæ, with the tentacles disposed in groups,—the ocelli are always situated on the under side of the tentacles in the form of a crescent.

In *Cladonema* and the allied *Eleutheria* of Quatrefages, a spherical, highly refractive corpuscle is lodged in the midst of the pigment. In *Eleutheria* this body is of considerable size, and projects above the surface.

B. Marginal bodies of the higher Medusæ.

In the lower Medusæ we have seen the two forms of marginal bodies existing in distinct families, but in the higher or steganophthalmatous group we see indications of the union of the two into a single organ.

In the simplest form of these bodies, as in *Pelagia* and *Cassiopeia,* they constitute vesicles of an oval form, somewhat acuminate at the free end, and wider at the opposite, supported on a short stem in the incision and between the lobes of the disc. Immediately above the notch in which the marginal body is lodged, runs a canal communicating with the contiguous prolongation of the gastric cavity. The canal at this point is slightly dilated and furnished with distinct walls. It enters the stem of the marginal body, running downwards in it for more than one third of its length, ultimately curving round nearly at a right angle with the longitudinal axis of the marginal vesicle.

The marginal body itself encloses an oval cavity also surrounded by a well-defined layer of tissue. The curved canal of the peduncle opens into this space, which would, in fact, represent a sudden dilatation of it. Thus, in the

higher Medusæ, there is a communication between the marginal vesicle and the gastro-vascular system, a fact disputed by Kölliker. The interior of the vesicle, like that of the canal, of which it is, as it were, a derivation, is lined with a very delicate ciliary investment, by means of which a constant circulation of the contained fluid is maintained. Kölliker and others have described an opening on the upper side of each marginal vesicle, through which the *ampulla* above described would communicate with the surrounding medium; but Gegenbaur denies altogether the existence of any openings of the kind.

At the free end of the marginal body, and constituting nearly its whole apex, is placed an oval sacculus, 0·14‴ long by 0·09‴ broad, closely filled with prismatic crystals, and which probably represents the most important physiological portion of the organ. The membrane of this sacculus is indeed thin, though possessing a certain resistance. At the sides and distal end it is enclosed by the walls of the marginal body itself, which are here somewhat thinned, whilst the part corresponding to the ampulla is covered with the ciliary lining of the latter. There is no communication between the ampulla and the crystalline sacculus. Gegenbaur has never perceived any movement in the crystals, and denies the existence of cilia in the sacculus containing them. The crystals themselves are six-sided prisms, obliquely truncated at each end; in length and number they vary very much. The longest measure 0·02‴. They appear to be insoluble in acetic acid.

Gegenbaur then proceeds to describe the unusual forms of marginal bodies which exist in species termed by him *Ephyropsis*,* and probably belonging to the genus *Nausitho*, of Kölliker,† and in *Carybdea marsupialis*, in both of which Medusæ, moreover, the ocelli contain sperical, refractive bodies.

After discussing the question concerning the function of these bodies, Gegenbaur inclines to the opinion, that the coloured spots, especially when furnished with a spherical refractive corpuscle, are of the nature of visual organs, whilst he throws out the supposition that the other kind may be excretory. Relying chiefly upon the absence of motility in the concretions or crystals, and of cilia in the cavities in which these bodies are lodged, he attempts to show the improbability of their being auditory organs.

* 'Comptes rendus,' t. xxxviii.
† 'Zeits. f. Wiss. Zool.,' Bd. iv, p. 323.

MODES *of* DETERMINING, *by the Use of the* MICROSCOPE, *the* REFRACTIVE INDEX *of* FLUIDS.

(Freely translated from the Dutch of Professor HARTING, of Utrecht. By WILLIAM ROBERTSON, M.D., F.R.C.P.E. See 'Het Mikroskoop,' Tweede Deel, b. 200.)

A KNOWLEDGE of the laws which the rays of light observe in their course through refracting media enables us, with the help of the microscope, to determine the index of refraction of certain substances, to which, on account either of their small quantity or of their insufficient transparency except when in layers of extreme thinness, the ordinary methods are inapplicable.

I. *Sir David Brewster's Method.*

It is many years since Brewster first used the microscope for this purpose. His mode of procedure is described in his 'Treatise on Philosophical Instruments,' Edinb., 1813, p. 240. He uses a compound microscope, the object-glass of which is a biconvex lens, with sides of equal curvature, and of considerable focal length. This lens is firmly fixed in the lower extremity of a brass ring, which is to be filled with the fluid whose refractive power is the subject of examination. The upper opening of the brass ring is then to be closed by laying on it a circular glass plate with parallel surfaces. The contained fluid now forms a plano-concave lens, the concavity of which rests on the upper side of the biconvex glass lens. The object-glass is thus converted into a plano-convex compound lens, resembling an achromatic combination of flint- and crown-glass, but with this difference, that in the former the convex surface is directed downwards and the flat surface upwards.

When the biconvex is thus converted into a plano-convex lens, its focal length becomes of course considerably augmented; and in like manner the distance at which an object must be placed in order to be clearly seen through the microscope becomes greater.

That the eye may in the course of a series of observations be as nearly as possible in the same state of accommodation, Brewster recommends the use of an eye-piece with a wire or glass fibre crossing its field, to form a distinct image on the retina at the commencement of each observation, and

thus secure the uniform exercise of the same amount of accommodating power.

For the calculation of the index of refraction we must have the following data:

1st. The radius of curvature of the biconvex lens $= r$.

2d. The distance between the biconvex lens and the object, when the latter is best seen, and *air* only is interposed between the lens and its covering-plate. This distance $= a$.

3d. The distance between the biconvex lens and the object, when the latter is best seen, and the space between lens and glass covering-plate is filled with the substance under ex nation. This distance $= b$.

If now we make the required index of refraction $= n$, we have the following equation:

$$n = 1 + \frac{(b - a)r}{ab}.$$

This formula has been communicated to me by my colleague, Van Rees, and I have substituted it for that given by Brewster, in which the index of refraction of the biconvex lens is assumed as known, which, however, can be the case only when such a lens has been made for this express purpose of glass whose index of refraction is ascertained before grinding.

The advantages of Brewster's method are, that it is not only applicable to fluid bodies, but to such as are so soft as to admit of being pressed into the lenticular form, even when their degree of transparency is but feeble—a case for which we can provide by causing the light to traverse a thinner layer of the substance under examination. Different bodies, such as wax, pitch, opium, &c., which are in mass absolutely opaque, become, when pressed into a thin layer, transparent enough to admit of the determination of their indices of refraction by this method.

The disadvantages of the procedure are the following. In the first place it requires the adaptation to the microscope of a special apparatus, consisting of an object-piece constructed for the purpose, and of a very accurate micrometric movement for measuring the distance at which the object is seen sharply defined. In the second place, the radius of curvature of the biconvex lens must be exactly known—one of the most difficult of requirements in the case of microscopic lenses. Finally, in the third place, the question arises—"from what point is the distance of the object to be measured?" Brewster seems to have used the lowest point of the lens as his "point de départ"—but this is not correct, for the true

point, the optical centre, is *in* the compound lens, and at a depth varying with the thickness of the layer and refracting power of the fluid which constitutes a part of the plano-convex lens. Hence it is hardly possible to measure the distance of the object with the degree of accuracy required for the subsequent calculation.

II. *Harting's Method.*

The following method may be followed with any microscope and without the addition of special apparatus; and although comparatively limited in its application, which is restricted to certain fluids, it affords indications of extreme exactitude when due attention is paid to the manipulation. It is free from the above-mentioned disadvantages of Brewster's method, and has the further recommendation that a very small quantity of fluid is required for each observation, even a few milligrammes amply sufficing for the determination of the index of refraction.

This method is founded upon the different dimensions of images of the same object placed at like distances from air-bells of like size in fluids of different refractive power. That this difference in the size of the images is rather considerable, the following examples will show:

Water .	$n = 1·336$	Diameter of image	$= 1000$
Sulph. acid .	„ 1·416	„ „	$= 749$
Canada balsam	„ 1·504	„ „	$= 582$

To enable us to calculate the index of refraction, it is necessary that there should be—

1st. A thin layer of the fluid between two plates of glass with parallel surfaces; also some air-bells in the fluid to act as dispersing lenses and form images of objects situated beneath them. To prepare the fluid for the observation, let a drop be placed on a thin glass plate, and some air-bells formed by blowing air into the fluid through a small glass tube drawn out very fine in the blowpipe flame. A small ring of paper is next laid round the drop, and on its surface a thin glass covering-plate is placed. It will then be found that some of the air-bells have lost their spherical form and are consequently useless for the purpose in hand. This will be quickly seen from the distortion of the images which they form—there will, however, always be present a few which will exhibit correct and sharply defined images. The thickness of the glass object-plate should not exceed $\frac{1}{5}$th of a millimetre $= \frac{1}{130}$th of an inch nearly: for a thicker plate would exercise on the course of the rays an influence which in the

subsequent calculation could not be neglected. An ordinary *thin glass* covering-plate may be conveniently used.

2d. It is necessary to provide an object, the diameter of which is very exactly known—the most suitable is a strip of metal coloured white. This strip should be placed beneath, and parallel with, the stage of the microscope, and should be so arranged on a proper holder that its middle point shall coincide precisely with the prolongation of the optical axis of the instrument.

3d. It is necessary to know, as nearly as possible, the distance between the upper surface of the object and the air-bell. In my investigations, I prefer a fixed distance of 100 millimetres, on account of the convenience of this round number in calculation. The construction of most microscopes also renders this a convenient distance. Between the distance and the diameter of the object a certain ratio should be observed. If the latter be more than *one fifth* of the former a correction of the final result becomes necessary, for in consequence of the excessive obliquity of the rays proceeding from the margins of the object, the difference between their angles of incidence and of refraction becomes too sensible to be neglected.

4th. The microscope being so arranged that the object is brought distinctly into view, the diameter of the air-bell and of the image of the object below it are to be successively measured; and in doing so it will be of course necessary to alter the focus of the instrument slightly, the margins of the air-bell and the image lying in different planes.

As the accuracy of the result in great measure depends upon these two measurements, it is scarcely possible to bestow too much care in taking them. For the methods to be followed in this stage of the observation, I refer to the chapter on Micrometry.* I must not neglect to add that these measurements should be made by *reflected* light—if transmitted light be used, the influence of diffraction causes the results to be somewhat too small. It is also advisable that the strip of metal used as an object should be of a *white* colour.

It is essential that the successive measurements of air-bell and image should be made rapidly, both in order to obviate the influence of changes of temperature, and because the gradual absorption of air by most fluids, and especially by

* In the 'Monthly Journal of Medical Science,' May, 1852, p. 453, a very full abstract of this chapter will be found. The most exact methods are those in which the screw-micrometer eye-piece or the plan of "double vision" are used. (T.)

those of organic origin, causes the diameter of the air-bell after a certain time to become notably diminished. We must not therefore rest satisfied with a single measurement, but take each set of dimensions again and again, and use in the final calculation the mean results of all.

Let us now suppose:

Distance between object and air-bell .	$= a.$
Diameter of the object	$= b.$
Diameter of image	$= c.$
Diameter of the air-bell	$= d.$

The index of refraction will then be obtained by means of the following formula, for which I am indebted to my colleague, Van Rees:

$$n = \frac{1}{2} + \sqrt{\frac{1}{4} + \frac{(b-c)d}{4ac}}$$

But as c may be regarded as infinitely small when compared with b,

$$n = \frac{1}{2} + \sqrt{\frac{1}{4} + \frac{bd}{4ac}}$$

The use of this formula enables us to deduce the refractive index with certainty to the third decimal place, but only when the above-mentioned conditions are attended to, and the final mean of several measurements is used as the basis of calculation. When a thicker object-plate, and especially when a larger object is used, there arises the necessity for different corrections, which cannot be neglected, and which render the computation troublesome and its result less exact.

If, as in the arrangement which I have recommended, $a = 100$, $b = 20$, or, in general, if $b = \frac{a}{5}$, then,

$$n = \frac{1}{2} + \sqrt{\frac{1}{4} + \frac{d}{20}}$$

Some results obtained by this method may be here subjoined, in order that the reader may form an estimate of the degree of accuracy of which it is susceptible.*

* The first two examples taken from Harting are all that we give here. (T.)

1. *Aqueous Humour from Cow's Eye.*

By measurement No. 1	.	$n = 1{\cdot}3495$
,, ,, 2	.	,, $1{\cdot}3457$
,, ,, 3	.	,, $1{\cdot}3494$
,, ,, 4	.	,, $1{\cdot}3496$
,, ,, 5	.	,, $1{\cdot}3465$
By mean	.	$n = 1{\cdot}3481$
Extreme difference of measures . .		$= 0{\cdot}0039$
Probable error of mean		$= 0{\cdot}0005$

2. *Vitreous Humour of same Eye.*

By measurement No. 1	.	$n = 1{\cdot}3412$
,, ,, 2	.	,, $1{\cdot}3421$
,, ,, 3	.	,, $1{\cdot}3474$
,, ,, 4	.	,, $1{\cdot}3464$
,, ,, 5	.	,, $1{\cdot}3426$
By mean	.	$n = 1{\cdot}3439$
Extreme difference of measures . .		$= 0{\cdot}0062$
Probable error of mean		$= 0{\cdot}0007$

III. *Moser's Method.*

An account of this method is contained in the 'Repertorium der Physik,' v, p. 395. Moser uses an object-piece of long focus, taken from a common *reading-microscope*, and fixed at one end of a tube of at least fourteen inches in length, to the other extremity of which an eye-piece is adapted. The refractive index of a transparent plate with parallel surfaces, or of a layer of fluid, is then found by the following formula: $x = r\left(1 - \frac{1}{n}\right)$. When an object is brought into focus, and the refractive medium then interposed, the tube must be lengthened, or rather the object-glass withdrawn to a certain distance, in order that a distinct view of the object may be obtained. The difference between these two focal distances is then called x, the thickness of the interposed refractive medium is termed r, and the index of refraction $= n$.

IV. *Bertin's Method.*

This method was communicated to the French Academy, through Regnault, in April, 1849, and a full account of it

was published by Bertin himself in the 'Ann. de Chimie et de Physique,' 1849, xxvi, p. 288. To determine the refractive index of a plate of glass, he proceeds as follows. A micrometer is used as an object, and its amplifications observed—*first,* as it lies *on* the glass plate; *second,* as it lies beneath it; and, *third,* as it rests on the stage without the interposition of the plate. In the course of these observations *the object-piece must remain a fixed point,* and the necessary motion be given to the eye-piece only. The successive amplifications, in the above order, are termed G, γ, g, and the formula for finding the index of refraction is

$$n = \frac{\gamma}{g} \cdot \frac{G - g}{G - \gamma}$$

When the plate is very thick, it is better to compare it with another whose index is already known. Then,

$$\frac{e = \left(1 - \frac{1}{n}\right)}{e' = \left(1 - \frac{1}{n'}\right)} = \frac{\frac{1}{g} - \frac{1}{\gamma}}{\frac{1}{g'} - \frac{1}{\gamma'}}$$

This method, like all the others which we have had occasion to describe, is also applicable to fluids. It is said, that its possible error cannot exceed 1 in the second place of decimals.

Note.—Of the comparative value of these four methods I have had no opportunity of judging; but on applying the second to the determination of the refractive power of water, turpentine, castor oil, and other fluids, I have found its results very uniform and satisfactory. (Trans.)

REVIEWS.

Archives of Medicine. Edited by Lionel Beale, M.B. London: Churchill.

This is the first number of a new medical periodical, but how often it is to appear the editor does not inform us. The object of the editor is to publish papers of a more thoroughly scientific character than are usually found in medical periodical literature, and to have these papers freely illustrated. The subjects on which he wishes to receive papers are as follows:

1. Practical clinical observations.
2. Original researches in Physiology and Pathology.
3. Chemical and Microscopical examination of the solids and fluids of the body.
4. Descriptions of scientific processes.
5. Condensed reports of researches published elsewhere.

The distinguishing features of this first number are the papers devoted to chemical and microscopical research and the accompanying lithographic plates. Of course microscopical examination is only one means pursued in the investigation of healthy or diseased structures, and in most of the papers in this first number we have observations recorded by the use of the microscope. As an example of the papers we republish one by the editor.

"*On the Manner in which the Drawings illustrating the Papers have been made, and of obtaining Lithographs from Microscopical Drawings.*

"I have always felt it very desirable that the description of scientific observations should be curtailed as far as is consistent with accuracy and perspicuity in the statement of the results, and it is my desire, as far as possible, to see drawings take the place of long and necessarily tedious descriptions of observations. Instead of alluding to the dimensions of an object in the text, the reader will be referred to the scales appended to every plate, and with the aid of very little trouble, the diameter of every object depicted may be readily ascertained. For all ordinary purposes it is only necessary to compare roughly the size of the drawing with the scale magnified in the same degree as the specimen itself, but in those instances where great accuracy is important, a pair of compasses may be used.

"In comparing the representation of the same object delineated by different observers, it will be often found that great confusion has been produced in

consequence of the magnifying power of the object-glass not having been accurately ascertained, and an object said to be magnified in the same degree by two authorities is not unfrequently represented much larger by one than by the other. This arises from the magnifying power of the glasses not having been accurately ascertained.

"I cannot too strongly recommend all microscopic observers to ascertain for themselves *the magnifying power of every object-glass*, and to prepare, in the manner presently to be described, *a scale of measurement by which the dimensions of every object can be at once ascertained.*

"The inconvenience of not being acquainted with the number of diameters which any object represented in a drawing is magnified, has been often felt; for without this it is impossible to judge of its real size. And, on the other hand, the annoyance of reading a long description of minute objects, differing slightly in size from one another, the dimensions of which have been accurately noted, is very great; while no corresponding advantage is derived from such minute measurements. The text becomes occupied with a multitude of figures of but little interest to the reader. At the same time, it is very desirable that the careful observations of different persons should be readily comparable with each other. Elaborate researches are not unfrequently deprived of much of their value in consequence of measurements having been carelessly taken, or the magnifying power of the glasses wrongly expressed.

"The plan of appending to every microscopical drawing a scale magnified in the same degree as the object represented, supersedes the necessity of giving measurements in the text, while it is free from any of the objections above referred to. I propose to describe briefly a very exact, and at the same time a very simple, method of applying scales to microscopical drawings. All the drawings illustrating the editor's papers may be measured by the scales at the bottom of the page, and he strongly recommends all contributors to follow the same plan.

"To carry out this it is necessary to ascertain the magnifying power of every object-glass, and to be provided with a stage micrometer divided into 100ths and 1000ths of an inch.

"*Mode of ascertaining the magnifying power of the object-glass.**—A glass micrometer divided into 100ths of an inch is placed in the focus of the object-glass of the microscope, which is arranged horizontally. The neutral tint glass-reflector is fitted to the extremity of the eye-piece, and the light carefully arranged so as to render the micrometer lines distinctly visible. Care must, however, be taken that the distance from the object-glass to the reflector is the same as from the latter to the paper beneath it, upon which the magnified micrometer lines may now be traced. A four- or six-inch scale accurately divided into 10ths of an inch is now applied to the magnified 100ths of an inch, and the magnifying power of the glass is at once ascertained. Suppose each magnified 100th of an inch covers 1 inch, the magnifying power will be 100 diameters, if an inch and 3 tenths 130 diameters, if 4 tenths of an inch 40 diameters, and so on, each 10th of an inch corresponding to a magnifying power of ten times.

"If we wish to ascertain the magnifying power of one of the higher object-glasses, a micrometer divided into 1000ths of an inch should be employed instead of the one just alluded to. In this last case, each tenth of an inch

* "This mode of measuring is alluded to in several works on the microscope, but the editor considers it sufficiently important to repeat here, especially as the drawings illustrating papers published in the 'Archives' have been copied in this manner."

upon the scale corresponds to a magnifying power of one hundred, instead of ten diameters. Any fractional parts can be readily estimated if we have a very accurately divided scale. This process must be repeated for every object-glass, as well as for each different eye-piece employed with the several objectives.

"*To ascertain the Diameter of an Object.*—If an object be substituted for the micrometer, and its outline carefully traced upon paper, its dimensions may of course be easily ascertained by comparison with the micrometer lines. The magnified power used being the same in both cases.

"In order to apply this plan to microscopical drawings generally, the following seems to be the simplest method of proceeding, and saves much trouble. Scales are carefully drawn upon gummed paper; the magnifying power, and the micrometer employed, being written against them as represented in the plates. If a number are drawn together one of the rows can be cut off and appended to the paper upon which the drawing, magnified of course to the same degree, has been made. This is the plan I have followed in all the drawings which illustrate my observations, and the scales have been copied in the lithographs. All magnifying glasses of the same focus do not magnify in precisely the same degree, so that it is necessary for every observer to ascertain for himself the magnifying power of his lenses, and he may construct little tables in the manner I have described.

"In order to make an accurate microscopical drawing, the image of the object is carefully traced on paper with the aid of the glass-reflector, and afterwards finished by the aid of the eye alone. In order to obtain the size accurately, care must be taken that the distance between the reflector and the paper is the same as that between the former and the object-glass. The drawing having been finished, one of the scales made as above described may be gummed on in one corner of the paper.

"*Of Drawing Objects in the Microscope, from which it is intended to take Lithographs.*—The lithographs illustrating the papers in the present number have been made by copying the image, with the aid of the reflector, on transfer-paper, with lithographic ink or chalk.*

"The drawing on the transfer-paper being complete, is transferred to a finely grained lithographic stone and properly fixed; impressions may then be taken off."†

All the papers in this number have greater or less merit, and we can cordially recommend Dr. Beale's 'Archives' to the patronage of our medical readers.

* "The best transfer-paper for this purpose is made of India paper. The ink and chalk can be purchased at any lithographer's. Fluid lithographic ink answers very well, and was used in making the drawings."

† "The drawings have all been carefully copied from the objects themselves on transfer-paper in my house, and then transferred to the stone. The transfers have been made and the impressions printed off by Messrs. Harrison and Sons, of St. Martin's Lane, and it is only right that I should thank those gentlemen for the trouble and interest they have taken, and for the kindness which they and their workmen have always shown in carrying out this plan of producing the drawings, as well as other suggestions which have been made."

The Microscope: its History, Construction, and Application. By JABEZ HOGG. Third Edition. London: Routledge.

WHEN Mr. Hogg's work first appeared, we predicted for it a large sale, on account of its excellent illustrations and low price. He tells us, in his preface to this, the third edition, that two editions, of five thousand each, have been sold, thus fulfilling our prophecy. We know, also, that other works have been equally successful, affording a gratifying proof of the extended interest taken in microscopic researches. In this third edition, Mr. Hogg has taken the opportunity of adding much new matter, and bringing up the information it contains to the time of publication.

Zoology; being a systematic account of the General Structure, Habits, Instincts, and Uses of the principal families of the Animal Kingdom. By W. B. CARPENTER, M.D. Vol. I. A new Edition, edited by W. S. DALLAS. London: Bohn.

WE call attention to this new and cheap edition of Dr. Carpenter's work on Zoology. It is now published in Mr. Bohn's series of standard scientific works, and has been brought up to the present requirements of the science of zoology by the aid of Mr. Dallas, whose scientific labours as a zoologist are well known.

PROCEEDINGS OF SOCIETIES.

MICROSCOPICAL SOCIETY, *October* 21*st*, 1857.

GEORGE SHADBOLT, Esq., President, in the chair.

A paper was read by Dr. Donkin, "On the Marine Diatomaceæ of Northumberland, with a description of twenty new species. ('Trans.,' p. 12.)

Another paper, by T. S. Ralph, Esq., "On a Mode of Illuminating Objects," was read.

November 11*th*, 1857.

GEORGE SHADBOLT, Esq., President, in the chair.

H. W. Lobb, Esq.; Samuel Mason, Esq.; John May, Esq.; Thomas Spencer, Esq.; and G. Y. Sharpe, Esq., were balloted for, and duly elected members of the Society.

A paper, by T. S. Ralph, Esq., "On a Mode of Perforating Glass Slides for Mounting Objects, and on various methods of Mounting Objects in them," was read. ('Trans.,' p. 34.)

Mr. R. J. Farrants made the following remarks:

"The author of the paper just read has noticed the want of a medium in which moist specimens could be mounted and preserved, the requisite properties being that it should '*viscify*,' and be readily miscible with glycerine and with water. This want is, in part at least, supplied by the gelatine medium of Mr. H. Deane, the formula for which was given in the third volume of the 'Transactions' of this Society, but which the author seems to have overlooked. This medium is rendered fluid by heat, the necessity for which in many cases precludes its use. In its stead I have for some time used a mixture of gum and glycerine, which I find suitable in all cases where the gelatine medium is proper, while it may also be used for mounting some other delicate structures for which the gelatine would be unsuitable. Gum in solution was, some years ago, extensively tried as a medium for mounting microscopic objects; but its tendency to crack when dry (by which it frequently happened that the object immersed in it was spoiled) was found to be an insuperable objection to its use, and it was, I believe, entirely superseded by Canada balsam. Now the tendency of the gum to crack on drying, may be altogether prevented by the

addition of glycerine to the solution: the proportions I have used are *equal parts* of gum, distilled water, and glycerine; to prevent the growth of minute algæ or fungi in the mixture I have added a little arsenic. The following is the formula I would recommend: Boil together, in a Florence flask or porcelain capsule, 3 grains of arsenious acid and 2 fluid ounces of distilled water; when cold filter through paper. Take of this arsenical solution 1 fluid ounce, of pure glycerine 1 fluid ounce, of pure gum acacia 1 ounce (Troy). The gum should be dissolved without heat; a fortnight or longer will be required for its complete solution: in the mean time the mixture should be occasionally stirred with a glass rod; it will be well not to shake the bottle so as to *froth* the mixture, for air introduced is retained with great tenacity, and many days elapse before it entirely disappears. If due care be taken in selecting pieces of gum transparent, bright, and *free from impurities*, the mixture will not need filtering; if, however, foreign matters have accidentally gained admission, the best substance through which to strain the mixture is fine cambric, through which a considerable quantity of clean, cold water has been made to flow, so as to wash away any dust or loose fibres of the fabric which might find their way into the mixture. This is an *almost saturated* solution of gum; it has nearly the consistence and appearance of fresh, pale Canada balsam, and is to be used in the same way, but without heat. The portion of the liquid which extends beyond the thin glass cover, soon dries (the water rapidly evaporating), the residue being a tough elastic compound of gum and glycerine, strongly adhering to the glass, and with no tendency to crack. The superfluity may be cut away with a knife, and any remaining smear be removed by a piece of soft rag moistened with clean cold water. The specimen may be left in this state like an ordinary 'balsam-mounted' object; or the edges of the thin glass cover may be coated with any of the cements commonly used for that purpose, or (which I prefer) a piece of tinfoil, with a hole of appropriate size, may be placed over the cover and be cemented to the slide with a solution of Canada balsam in ether. The most delicate structures are well shown and preserved in this medium—such as thin sections of recent vegetables, starch corpuscles, mycelium, and sporules of fungi; cells, vegetable or animal; the thin, delicate membrane of small hydatid cysts, &c. Pathological specimens, so difficult to keep unchanged for more than a short time, have been better preserved in this medium than in any other with which I am acquainted; cancer cells, for example, have been kept unal-

tered in their optical characters for a period of two years: beyond this my experience does not extend. I indeed have no reason for supposing that specimens which have remained so long unchanged should not continue well preserved; further experience will, however, afford the surest means of determining the sufficiency of the medium as a preservative. Some recent and moist structures, animal and vegetable, admit of being mounted in Canada balsam without being previously dried; the advantage of this is, that the parts of an object are not distorted, as must, to a greater or less extent, always happen when a specimen is completely desiccated. The manner of proceeding is as follows: Take the specimen from the water or other liquid in which it has been prepared, let it drain a little, and then immerse it in rectified spirits of wine; after a short time (varying from *one or two* to *ten or fifteen* minutes, according to the size and thickness of the specimen), remove it from the alcohol, and, after draining, place it in *methylic alcohol,* otherwise known as *pyroxilic spirit, pyro-acetic spirit,* &c. After allowing it to remain a few minutes in this liquid, it may be removed, drained, and immersed in spirits of turpentine, on being taken from which, after a few minutes, it may be placed in balsam, and be proceeded with in the usual manner; the balsam ought to be sufficiently fluid not to need the employment of heat. It is recommended to pass the specimen from *common* to *methylic* alcohol, and thence to spirits of turpentine, because the turpentine mixes more readily with the latter than with the former; observe, however, that the spirit referred to is TRUE *methylic alcohol,* or pyroxilic spirit, not what is commonly known as *methylated* spirit, which is common alcohol contaminated with wood-naphtha, &c. Injected preparations are well preserved and displayed in this way: there is no displacement or distortion of parts, and while the vessels are shown in their true position and relations, the object is more securely and permanently preserved than if mounted in a cell with liquid in the ordinary manner; for, notwithstanding the greatest care cells *will leak,* and there are I believe few collections which after a lapse of four or five years will not contain cells into which air has passed, and from which a corresponding quantity of the original liquid has escaped. It has been said that this way of mounting objects in Canada balsam is neither original nor new, and in order that merit may be given where, it is said, merit is justly due, reference has been made to some beautiful preparations of the nerves, &c., by Dr. Andrew Clark, put up in this way a year and a half or two years ago.

I reply that I do not claim any merit either for originality in proposing, or for priority in using this plan, which indeed is likely enough to have occurred to many persons who have been much occupied in preparing and mounting objects for the microscope; as, however, I thought it not unlikely that this method might be unknown to some persons present, and judged also that the place and the occasion were proper, I ventured to mention it. Perhaps I may be allowed to add that I have specimens of injections prepared and mounted in this way as long ago as 1850, and though at first I had recourse to this method but rarely, being uncertain about its permanence, I have now for several years mounted 'injections' almost exclusively in this way, either in cells or without them, as the thickness of the specimen required. I have also a pretty extensive series of sections of the roots, woods, and barks of the Materia Medica, prepared and mounted in this way, with the advantage of well-secured objects, without falsification of the optical characters of the structures."

Mr. Wenham said—"Having had considerable experience in working glass, for optical purposes, I may state, that I frequently make use of hard steel with turpentine for rapidly reducing to form pieces of glass chucked in the lathe. I take a three-square saw-file, and grind away *one* of the faces as it loses its keenness and becomes worn; this constantly leaves two sharp serrated edges, which are applied to the revolving piece of glass, 'overhand' or in the way that a spoke-shave is used, supporting the file on the T rest, which is raised nearly level with the top of the work. I also employ turpentine for drilling glass. If the drill is made of the hardest cast steel, and hardened by quenching in dilute sulphuric acid, without being afterwards tempered, I can drill an eighth-inch hole through a plate of glass one inch thick in about one minute. The drill should be sharpened on both sides, so as to cut either backwards or forwards, and is best worked by the Archimedean drill-stock. Most glass is somewhat softer than hardened steel, but if the attempt be made to drill glass *dry*, a very intense heat is generated on the cutting edge, which destroys the temper and softens a very minute superficial film of the steel, which is then rubbed away, leaving a round edge unsuitable for cutting. The turpentine does not act in any peculiar way upon the glass itself, but its extreme fluidity and penetrating quality enables it to bathe the end of the drill during its rapid rotation, and by thus keeping it cool its hardness is maintained. For glass-turning I prefer old turpentine, as

it does not evaporate quite so readily. There is another point that I may notice in the paper that has just been read. The author mentions that by cutting off the heads of flies and grasping one of them between the finger and thumb the proboscis with all its apparatus will be protruded in the symmetrical arrangement proper for mounting. I invariably make use of this method. Take the proboscis of the *blowfly* for example. The flies are best when very young, having been hatched in a dark box, otherwise their probosces will be opaque and more intractable than when they have not been hardened by exposure to air and light. Having cut off the heads, they should be macerated for some hours in water, then on grasping the head between the finger and thumb, the proboscis will become highly inflated (indeed if the pressure is too great it will burst), then nip it between two slips of glass, having a small elastic band around them, to spring them together, now cut off the head, and leave the proboscis under pressure until it is dry; it will then retain its form, which will be quite symmetrical, and may be finally mounted in Canada balsam in the usual way."

After some remarks from Mr. Brooke the discussion closed.

The final Report of the Committee "On the best uniform method of attaching Object-Glasses to Microscopes," was read. Resolved that it be received and adopted. ('Trans,' p. 39.)

December 9th, 1857.

GEORGE SHADBOLT, Esq., President, in the chair.

Captain John Peel, 14, Ulster Place; Geoffrey Bevington, Esq., Wandsworth Common; J. J. Harding, Esq., 1, Barnsbury Park; J. W. Harker, Esq., 24, Upper Barnsbury Street, were balloted for, and duly elected members of the Society.

A short paper by Mr. B. J. Nowell was read, "On the Menai Straits as a locality for the Collection of Diatomaceæ." The author adverts to the fact that the mud of which some portion of the shore is composed is particularly rich in Diatomaceæ, and states that the gathering is best pursued between high and low water mark, the surface and the bottoms of the little pools being skimmed in the usual manner. The united proceeds of these skimmings are to be placed in a shallow vessel and exposed to the sun for some time and then re-skimmed. It is then recommended that the usual manipulations with hydrochloric and nitric acids, assisted by heat, should be performed, the "result being a collection replete with beautiful forms." Some slides containing the forms collected in this way having been transmitted by the author

to the President, that gentleman furnished the meeting with the following list of species observed by him on the inspection (cursory) of a few slides, and from which the richness of the locality may be judged of.

List of Species of Diatoms noticed in Mud from the Menai Straits

Coscinodiscus radiatus.	*Pleurosigma angulatum.*
,, *minor.*	,, *decorum.*
,, *excentricus.*	,, *litorale.*
Eupodiscus sculptus.	,, *distortum.*
,, *fulvus.*	,, ? n. sp.
,, *crassus.*	*Grammatophora marina.*
,, *radiatus.*	,, *serpentina.*
Actinocyclus undulatus.	*Melosira maculata.*
Actinophænia splendens.	*Orthosira arenaria.*
Triceratium favus.	*Biddulphia rhombus.*
,, *elliptica.*	,, *aurita.*
,, *amphisbæna.*	,, *turgida.*
Pleurosigma balticum.	

"On a peculiar Larvæ Form resembling Pluteus," by Dr. Cobbold. ('Trans.,' p. 50.)

"Directions for Making Spherules of Calcareous Salts, with some Observations on Molecular Coalescence," by G. Rainey, Esq. ('Trans.,' p. 41.)

A discussion followed the reading of this paper.

Professor Quekett stated that he had observed crystalline spherules in the urine of the horse, in a specimen which had been kept for many years in the Museum of the Royal College of Surgeons.

Dr. Carpenter thought Mr. Rainey's observations very important; but he believed that in shells there was a true cellular structure.

Dr. Lankester said that Mr. Rainey's observations were interesting in connection with those made by Mr. Sorby on the physical causes producing the Oolitic structure in rocks.

Professor Busk referred to an oolitic deposit in the lake of Mexico, which was produced, not by physical causes or spherulation, but by the deposit of calcareous matter on the surface of the ova of an insect which lived in the lake. The ova, when recent, were eaten by the natives; but those which were not taken for this purpose became cemented into a true oolitic petrifaction.

ZOOPHYTOLOGY.

For the interesting additions to the Zoophytological Fauna of Madeira, contained in the following list, we have been indebted to Mr. J. Yates Johnson, so well known as an assiduous cultivator of the natural history of that island, and more especially of its marine productions. It is needless to insist upon the importance of contributions from such a locality towards a more complete knowledge than we as yet possess of the geographical disposition of species; but the consideration simply of such a short list as the present suffices to indicate that, so far as its Zoophytology is concerned, Madeira forms a connecting link between the Mediterranean, on the one hand, and with the Western and Eastern shores of Africa and of South America respectively, on the other; connected with the latter, perhaps, through the intervention of the Gulf-weed.

The number of species comprised in the collection is about twenty-four, of which twenty belong to the Polyzoa, and four to the class of Sertularian Hydrozoa.

The Polyzoa are arranged in the following families, with the characters given in the 'B. M. Cat.:'

1. Scrupariadæ.
2. Salicornariadæ.
3. Bicellariadæ.
4. Membraniporidæ.
5. Celleporidæ.
6. Selenariadæ.
7. Idmoneadæ.
8. Crisiadæ.

Class. POLYZOA.

1. Sub-order. CHEILOSTOMATA.

1. Fam. SCRUPARIADÆ, Gray.

1. Gen. *Eucratea*, Lamx.
Unicellaria, Blainville.

1. *E. Lafontii*, Audouin, 'Expl.,' p. 242; Savigny, 'Egypt,' pl. xiii, fig. 2.

This beautiful and very remarkable species belongs to the Mediterranean Fauna, occurring on the coast of Syria. It

probably deserves to be raised to the rank of a distinct generic type, in which case the name of Eucratea (Aud.) might be retained for it and the *E. Cordieri* of the same author.

2. Fam. SALICORNARIADÆ, Busk ('B. M. C.,' p. 15).

2. Gen. *Nellia*, Busk ('B. M. C.,' p. 18).

1. *N. Johnsoni*, n. sp. Pl. XIX, fig. 2.

Front of cell pyriform, pointed at bottom; margin raised, thick, smooth. Mouth semi-orbicular, lower lip straight. Ovicell (?).

Hab. Madeira, Johnson.

Two small fragments only occur of this apparently distinct form. The natural size is shown in the plate.

3. Fam. BICELLARIADÆ, Busk ('B. M. C.,' p. 41).

3. Gen. *Bugula*, Oken.

1. *B. gracilis*, n. sp. Pl. XIX, fig. 1.

Cells biserial, elongated, of nearly uniform width throughout; a short spine on each angle of the aperture. Aperture not extending below the middle of the cell. Avicularia capitate, blunt (?), of uniform size.

Hab. Madeira, Johnson.

Although, in the character of the cell, this species approaches in some respects near to *B. plumosa*, and in the number of spines to *B. turbinata* (Alder), the comparative shortness of the aperture and, above all, the extremely different habit, so far as that can be judged of from the small specimen seen by us, appear to afford sufficient grounds for its being regarded as distinct from either.

3. *B. flabellata ?* Thompson.

a. var. *biseriata* s. *Ditrupæ.*

Although we have named the form as above, it will probably have to be regarded as a distinct species. Its habitat is very peculiar, and as in the very numerous specimens shown to us by Mr. Johnson, the most remarkable uniformity was exhibited, both in this respect, and in general size and habit, and no indication whatever existed of a nearer approach to the usual form of *B. flabellata*, this supposition is rendered the more probable. The *Bugula* always grows in a small tuft, about half an inch in height, and consisting of three to four narrow branches, close to the mouth of a species of *Ditrupa* (*D. acuminata*). It might on this account, perhaps, be denominated *B. Ditrupæ.* A figure and fuller description of it will be given in a future number of the 'Journal.'

4. Fam. Membraniporidæ, Busk ('B. M. C.,' p. 55).

4. Gen. *Membranipora*, Blainville.

1. *M. tuberculata*, Bosc. Pl. XVIII, fig. 4.

Cells oval; margin granular; aperture partially filled in all round by an irregular jagged calcareous expansion; two to four blunt spines or tubercles above the cell, often united into a single bifid knob.

Hab. Madeira, Johnson; Rio de Janeiro, M'gillivray; Gulf-weed *ubique;* on fuci.

Flustra tuberculata, Bosc, 'Vers.,' 2d ed., t. iii, p. 143 (*ex. syn.*)
Flustra membranacea, Esper, 'Flustra,' pl. v.

This very abundant and extensively spread species we had formerly confounded with *M. membranacea* ('B. M. Cat.,' p. 56, pl. lxviii, fig. 2), with which, on superficial inspection, we regarded it as identical, until our attention was directed to it by Mr. Alder, who was inclined to consider it as distinct from that well-known form. We are inclined to regard this opinion as correct. The way in which it covers the air-vesicles of *Fucus natans* with its beautiful calcareous network, and spreads over the surface of other Fuci, closely resembling the habit of *M. membranacea,* taken with the circumstance of each cell being crowned with two short tubercular spines, on a cursory glance naturally induced the supposition that the two forms were identical. They differ, however, in several important particulars. *M. tuberculata* appears to be far more calcareous than *M. membranacea.* The front of the cell is not oblong and angular, as is usually the case in the other species. The margin in *M. membranacea* is thin and smooth, and the area is not encroached upon by a calcareous expansion. The spines, also, as Mr. Alder points out, in *M. membranacea* are usually, in part at least, flexible or corneous (though this is not always the case), whilst in *M. tuberculata* they appear to be invariably calcareous, short, thick, and blunt; and in the older cells usually united, so as to form a transversely elongated tubercle, thicker and more elevated at the sides. The form appears to be confined to the South Atlantic, and it is very generally met with on the Gulf-weed. With respect to the appellation, it seems quite clear that this is the form intended by Bosc under the name of *Flustra tuberculata,* and there is no reason, therefore, that his designation should not be retained. Esper's plate (we have not been able to refer to the text) is a very good representation of the species as it occurs on *Fucus natans.*

Our figure gives a bad idea of the *M. tuberculata,* and a better will be given in a subsequent number.

2. *M. trichophora*, n. sp. Pl. XVIII, fig. 2.

Front of cell oval, expanded below and contracted above; margin smooth

or very faintly granular; no calcareous expansion; one or two very long, slender, hair-like marginal spines on either side of the upper part of the cell. Ovicell small, immersed?

Hab. Madeira, Johnson (on shell).

The only form with which this can be confounded is *M. Flemingii*, Busk ('B. M. Cat.,' p. 58, pl. lxi, fig. 2, and pl. lxxxiv, figs. 4—6), but from which it is clearly distinguished by the characters above given, and especially by the absence of any calcareous expansion, and the extraordinary length and slenderness of the hair-like spines.

3. *M.* , n. sp.

A figure and description of this species will be given hereafter.

5. Gen. *Lepralia*, Johnson.

1. *L. distoma*, n. sp. Pl. XVIII, fig. 1.

Cells pyriform, attenuated below. Mouth semi-orbicular, with a straight lower lip, separated only by a narrow bar from an avicularium, the opening of which is nearly as large as the mouth, the two openings being encircled by a raised border common to both. A depressed space on the front of the cell, the bottom of which is perforated with six or seven pores. A row of distant pores around the border of the cell.

Hab. Madeira (on fucus?), Johnson.

From the form of the small fragments in our possession they would seem to be growing all round the slender branches of a fucus, but the species may turn out to belong to the ligulate *Escharæ*.

2. *L. vulgaris*, Moll. Pl. XVIII, fig. 3.

Cells oval, convex; surface subgranular. Mouth semi-orbicular, lower lip straight, with a median notch. Three or four superior marginal spines. Ovicell small rounded. A slender vibraculum on each side of the cell about the middle.

Hab. Madeira, Johnson; Mediterranean, Moll.

Eschara vulgaris, Moll., 'Eschara,' p. 55, pl. iii, fig. 10.
Escharina vulgaris, Lamarck, 'H. n. d. s. V.,' 2d ed., t. ii, p. 231 (*ex. syn. E. Dutertrei*).
Cellepora vulgaris, Lamx., 'Hist.,' p. 94.

From Moll's account, and the name he has given to this species, it would seem to be very common in the Mediterranean.

3. *L.* ? n. sp.

This species will be afterwards described and figured.

4. *L.* , n. sp.? resembling *L. ventricosa*.

This species will be afterwards described and figured.

5. *L. sceletos*, n. sp.

This species will be afterwards described and figured.

6. *L. radiata*, Moll.

Cells sub-oval, marked in front with radiating lines of pores, in a circumscribed, nearly circular, raised space, usually not occupying the entire front of the cell. Mouth semi-orbicular. Four to six marginal spines. Numerous long intercellular blunt avicularia scattered over the polyzoary.

Hab. Madeira (on shell?), Johnson; Mediterranean, Moll; *Eschara radiata*, Moll, 'Eschara,' p. 63, pl. iv, fig. 17.

It does not seem quite clear whether this species should be referred to *Lepralia* or *Eschara*, inasmuch as in one of the small specimens brought under our notice, it seemed as if the growth sometimes rose up in an independent frond from the surface upon which the rest of the polyzoary was spread. We have followed Moll, however, in regarding it, at any rate provisionally, as a Lepralia. He states that this very elegant species covers other zoophytes and shells with a single layer of cells. The cells, as he observes, are much crowded, and consequently not unfrequently deformed and irregular in their disposition. He describes the radiating line of puncta as constituted of granules, but they are clearly rows of minute pores. His description of the avicularia is very good.

5. Fam. CELLEPORIDÆ, Busk ('B. M. C.,' p. 85).

6. Gen. *Cellepora*, O. Fabricius.

1. *C. Hassallii* (?), Johnst.

This name is only given provisionally, though it will probably prove to be correctly applied. A figure and description of the form will be given hereafter.

2. *C. ramulosa*, Linn.

6. Fam. SELENARIADÆ, Busk (' B. M. C.,' p. 97).

7. Gen. *Cupularia*, Lamx.

1. *C. Lowei*, Busk ('B. M. C.,' p. 99, pl cxvi).
2. *C.* , n. sp.?
3. *C.* , n. sp.?

Figures and descriptions of these two apparently new species of *Cupularia* will be given hereafter.

2. Sub-order. CYCLOSTOMATA.

1. Fam. IDMONEADÆ, Busk.

1. Gen. *Idmonea*, Lamx.

1. *I. Atlantica*, E. Forbes. Pl. XVIII, fig. 5.

Except, perhaps, in its comparatively greater size and more robust habit, this form does not appear to differ in any material respect from that which occurs in the Northern

seas. (*Vid.* 'Annals Nat. Hist.,' 2d ser., vol. xviii., p. 34, pl. i., fig. 6.)

2. Fam. Crisiadæ.

Two species of Crisia, one of which appears to correspond with *C. dentata* in a dwarf state, and the other to be as yet undescribed, will be figured and described in a subsequent number.

Hydrozoa.

Fam. Sertulariadæ.

1. Gen. *Sertularia*, Linn.

1. *S. disticha*, Bosc.

Hab. Madeira (on fucus), Johnson.

S. disticha, Bosc., 'Vers,' 2d ed., t. iii, p. 121, pl, xxii, fig. 2; Lamarck, 'Hist. d. An. s. V.,' p. 154.
Dynamena disticha, Audouin, 'Expl.,' I, p. 244; Savigny, 'Egypt,' pl. xiv, fig. 2; Lamouroux, 'Hist. d. Cor. flex.,' p. 181; Blainville, 'Act.,' p. 484.
Dynamena distans, Bosc, op. cit., p. 121; Audouin, 'Expl.,' p. 243; Savigny, 'Egypt,' pl. xiv, fig. 1.

There appears to be no sufficient reason, from anything which appears in the excellent figures of Savigny, why *D. disticha* and *distans* should be separated. They both occur on the Gulf-weed.

2. *S. polyzonias*, Linn. (in part). (Ellis, 'Corallines,' pl. ii, fig. B.; *S. Ellisii*, M. Edw. in Lamarck's 'Hist. d. An. s. V.,' 2d ed., t. iii, p. 142.)

We are indebted to Mr. Alder for the distinction from *S. polyzonias* (Linn. et Auct.) of a species having only three denticles or angles on the mouth of the cell, in place of four which may almost always be distinguished in *S. polyzonias*. This species, under the name of *S. tricuspidata*, is described and figured in his Catalogue of Zooph. of Northumb. and Durham' (p. 21, pl. ii, figs. 1, 2). An additional character, however, might perhaps be appended to those there given as distinguishing *S. tricuspidata* from *S. polyzonias*, the absence, viz., of four denticles from the mouth of the ovicell, both male and female, which always exist in *S. polyzonias*.

Besides this, however, there seems reason to believe, notwithstanding Dr. Johnston's weighty authority on the other side, that M. Edwards was right in suggesting that *S. polyzonias* should be divided into two species, also distinguished by the presence and absence of the denticles at the mouth of the ovicell. In the form for which he proposes the name *S. Ellisii*, the ovicell is clearly represented by Ellis

(fig. B,) as it is in nature, with four denticles, whilst in that marked A in the same plate, the ovicell is represented very like that of *S. tricuspidata.* In the ventricose form of the cells, however, Ellis's fig. A differs so widely from Mr. Alder's *S. tricuspidata,* that it cannot be referred to that species; so that it is not improbable a third species, for which M. Edwards would retain the term *S. polyzonias,* may be included in the Linnean species.

The differences in the mouth of the ovicell do not depend upon sex, for although a considerable difference may be perceived between the small white male cell and the larger yellow female capsule, in *S. polyzonias,* the mouth has the same conformation in both.

2. Gen. *Cryptolaria,* Busk (Micros. Journ., Vol. V, p. 173).

1. *C. exserta,* n. sp. Pl. XIX, fig. 3.

Mouth of cells exserted. Polypidom pinnate or bipinnate; branches straight, rigid. Ovicell ?

Hab. Madeira, Johnson.

This appears to constitute a second species of the genus *Cryptolaria,* the other belonging to New Zealand, and in which the mouth of the cell is completely immersed.

3. *Plumularia.*

A new species, belonging to the *P. pinnata*-group, will be described subsequently.

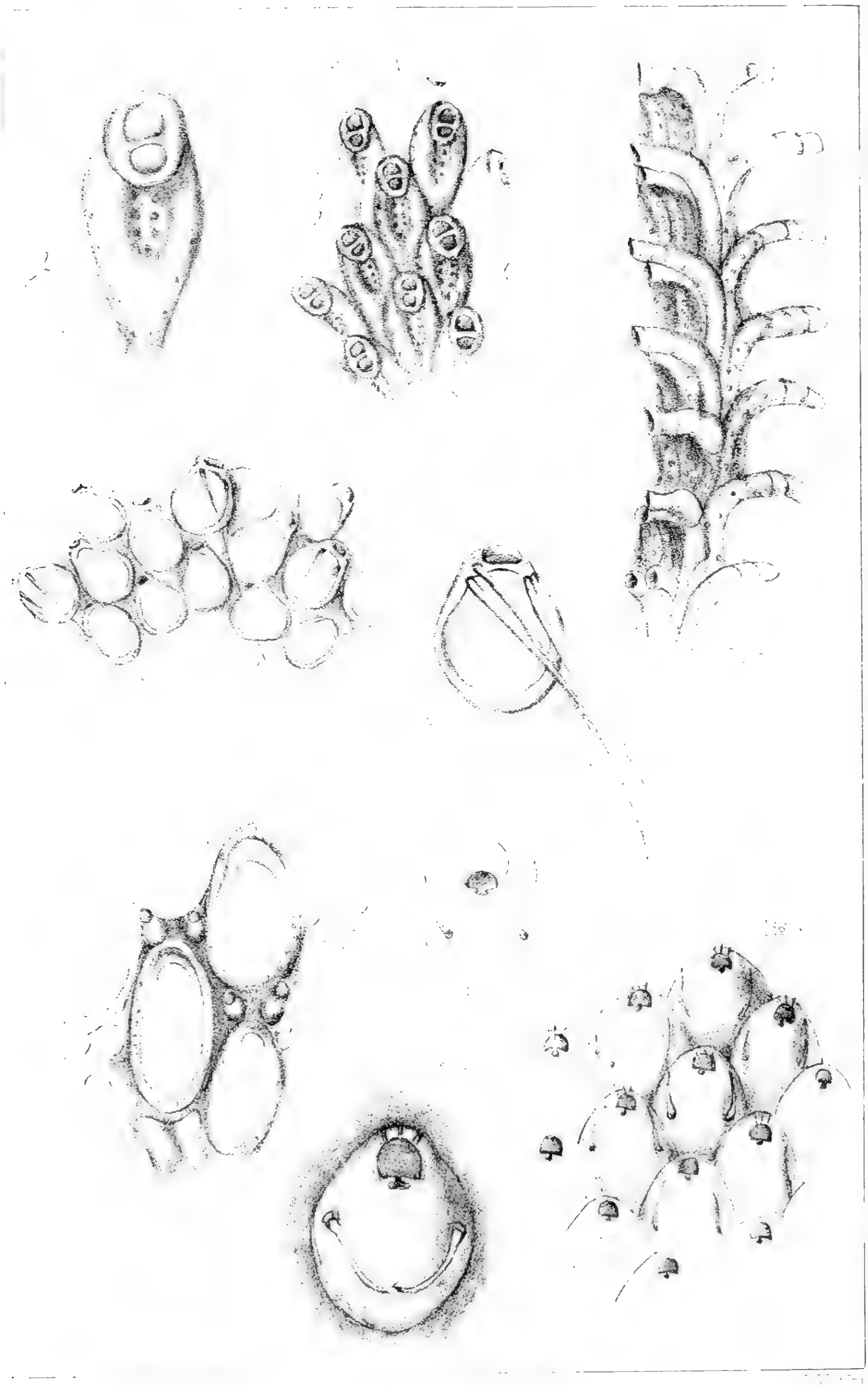



Fig. 2

ZOOPHYTOLOGY.

DESCRIPTION OF PLATES.

PLATE XVIII.

Fig.

1.—*Lepralia distoma*, × 25 d.

1 *a*.. × 50 d.

2.—*Membranipora trichophora*, × 25 d.

2 *a*. × 50 d.

3.—*L. vulgaris*, × 25 d.

3 *a*. × 50 d.

3 *b*.—Ovicell, × 25 d.

4.—*Membranipora tuberculata*, × 50 d.

5.—*Idmonea Atlantica*, × 25 d.

PLATE XIX.

1.—*B. gracilis*, × 50 d.

2.—*Nellia Johnsoni*, n. sp.

2 *a*. × 50 d.

3.—*Cryptolaria exserta*, n. sp.

3 *a*. × 25 d.

3 *b*. × 50 d.

DESCRIPTION OF PLATE III,

Illustrating Mr. Roper's paper on some New British Diatomaceæ.

Fig.

1.—*Eupodiscus tesselatus.*

b. Ditto, structure highly magnified.

2.—*Coscinodiscus labyrinthus.*

b. Ditto, structure highly magnified.

3.—*C.* (?) *stellaris.*

4.—*C.* (?) *ovalis.*

5.—*Actinocyclus triradiatus.*

b. Ditto, structure highly magnified.

6.—*Nitzchia virgataab.*

a. Side view.

b. Front view.

7.—*Amphora sulcata.*

8.—*A. membranacea.*

b. Ditto, represents self-division.

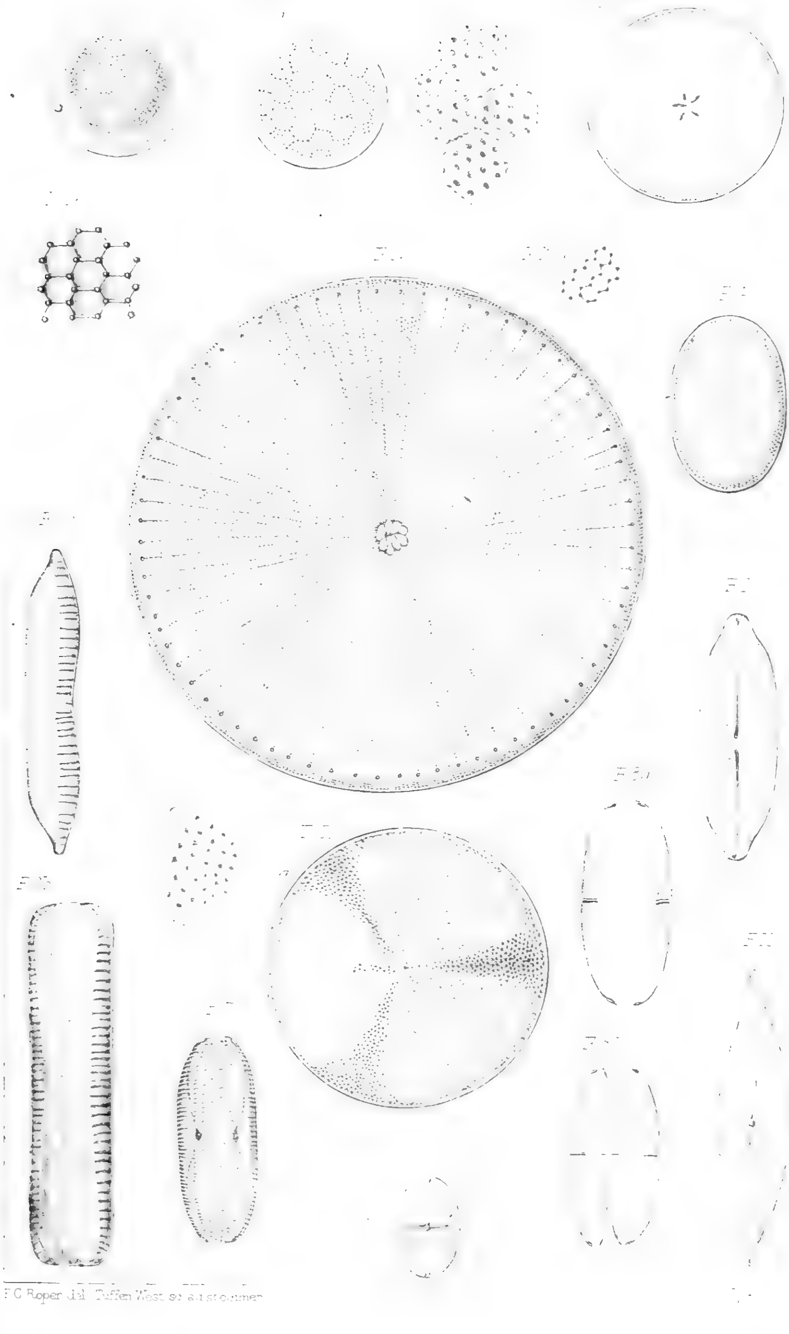
9.—*Cocconeis scutellum,* var. γ.

10.—*Navicula liber,* var. β.

11.—*Pleurosigma transversale,* var. β.

12.—*Coscinodiscus concinnus.*

a. Ditto, structure highly magnified.



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Tuffen West sc.

DESCRIPTION OF PLATE IV,

Illustrating Dr. Redfern's paper on *Flustrella hispida.*

Fig.

1.—Cœnœcium of *Flustrella hispida* removed by horizontal section from the frond of *Chondrus mamillosus.*

2.—Ditto, ditto, showing cells with fewer hairs on their sides and a more imbricated arrangement.

3.—A single cell of the same separated from those which surrounded it. Figs. 1, 2, and 3 magnified.

3 *bis.*—Cœnœcium of a specimen gathered on the coast of North Wales.

4.—Polypide removed from its cell, showing its digestive viscera.

5.—Portion of a tentacle, showing the natural state of its investing ciliated epithelium.

6.—Ditto, denuded of its epithelium.

7.—Ditto, showing its epithelial cells distended by fresh water. Figs. 5, 6, and 7 magnified.

8 to 10.—Unciliated ova or statoblasts densely filled with cells.

9.—Ditto, from which some of the cells have escaped, showing the remaining contents more distinctly cellular. Figs. 4, 8, 9, and 10 magnified.

11.—A single polypide in its cell, with a gemma forming on its wall.

12.—The same after two days, showing a striation produced by rows of highly refractive corpuscles.

13.—Ditto, on the third day, showing the polypide like a bud at the bottom of the new cell.

14.—Ditto, on the fourth day, showing traces of the formation of three other gemmæ.

15.—Ditto, on the seventh day. The polypide has assumed the form of a bent tube; the cell has four well-marked hairs formed on it; one only of the other gemmæ is now distinctly seen.

16.—Ditto, on the twelfth day. The projecting part of the cell has become flexible and greatly more prominent; the wall of the perigastric space and the tentacles are quite distinctly seen; no other gemma is distinctly visible.

17 and 18.—Ditto, on the thirteenth day, showing states of retraction and protrusion. The movements are now remarkably distinct, the tentacles much longer, the perigastric space clearer, the rows of refractive globules greatly diminished in number and size.

19 and 20.—Ditto, on the seventeenth day, showing the whole digestive system beautifully distinct, as well in the state of retraction as of protrusion; a gemma appears to be forming on the side of the newly developed cell.

DESCRIPTION OF PLATE V,

Illustrating Mr. Brightwell's paper on Rhizosolenia.

Fig.

1.—*Rhizosolenia ornithoglossa*, copied from Ehrenberg.

2.— „ *Calyptra*, ditto.

3.— „ *Americana*, ditto.

4.— „ *hebetata*, Bailey. Original figure.

5.— „ *styliformis*, n. sp. A very small entire frustule.

a. „ „ calyptriform valve, detached, seen on the ventral aspect.

b. „ „ calyptriform valve, dorsal aspect, and proximal portion of a frustule, breaking up.

c. „ „ calyptriform valve, lateral aspect, and portion of a frustule attached.

d. „ „ portion of one of the slenderest frustules, lengthening of intermediate portion, and formation of new "annuli."

e. „ „ portion of the broadest frustule yet found, ·0053 in diameter.

6.—*Rhizosolenia imbricata*, n. sp., in self-division.

7.—*a.* „ *setigera*, n. sp., self-division just commenced.

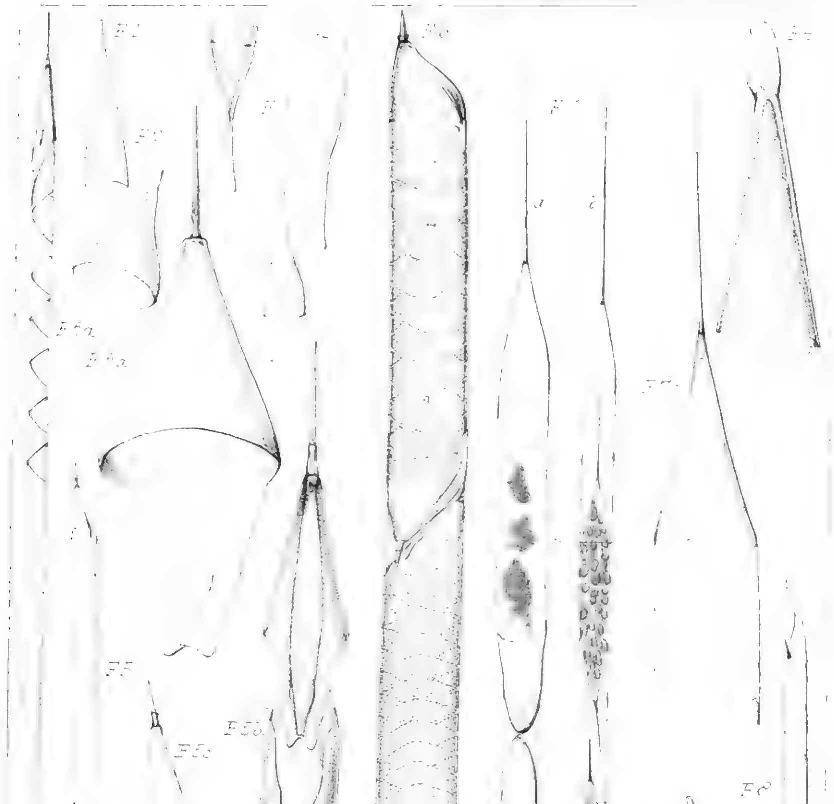
b. „ „ the same state, further advanced; the transparent portion above the dotted line was seen by Col. Baddeley (to whom we are indebted for the drawings from which figs. 7 *a*, 7 *b*, 7 *c*, were taken) to become detached and thrown off.

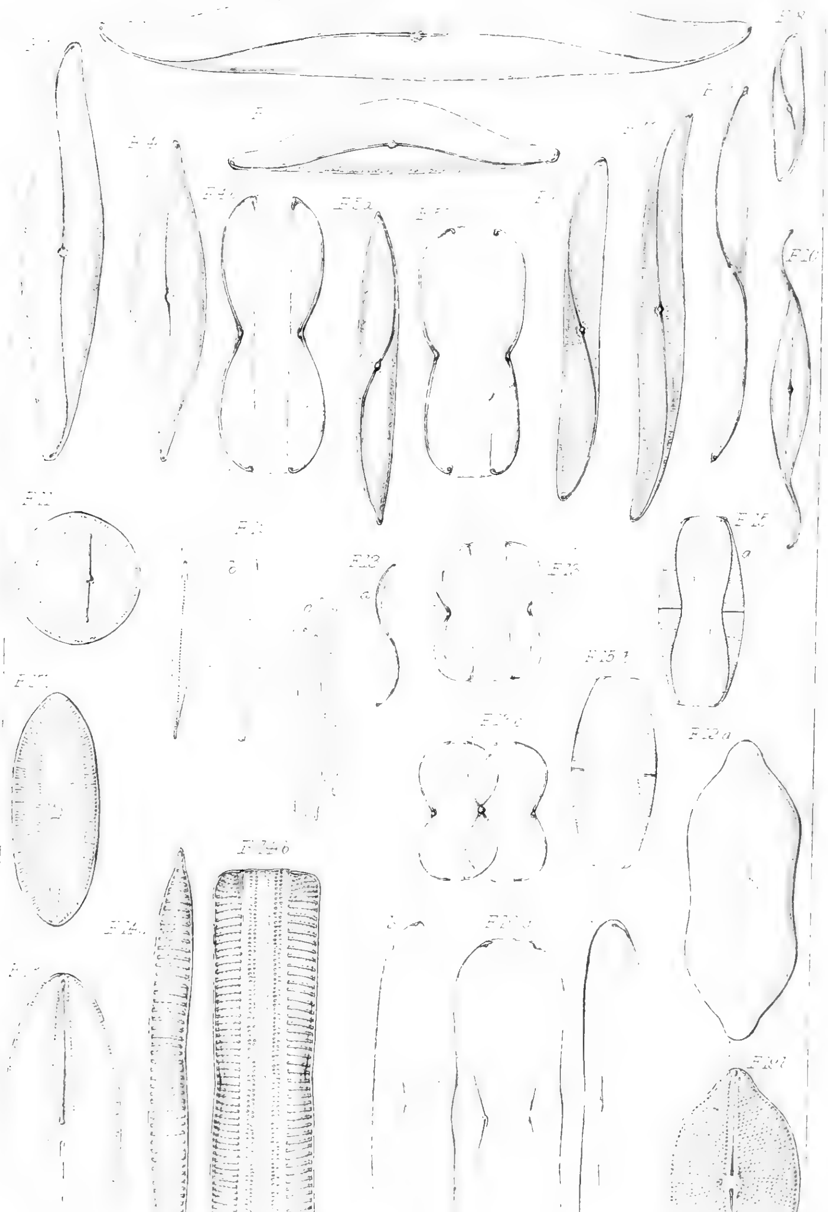
c. *R. setigera*, showing the very faint markings on the intervalvular portion of the frustule.

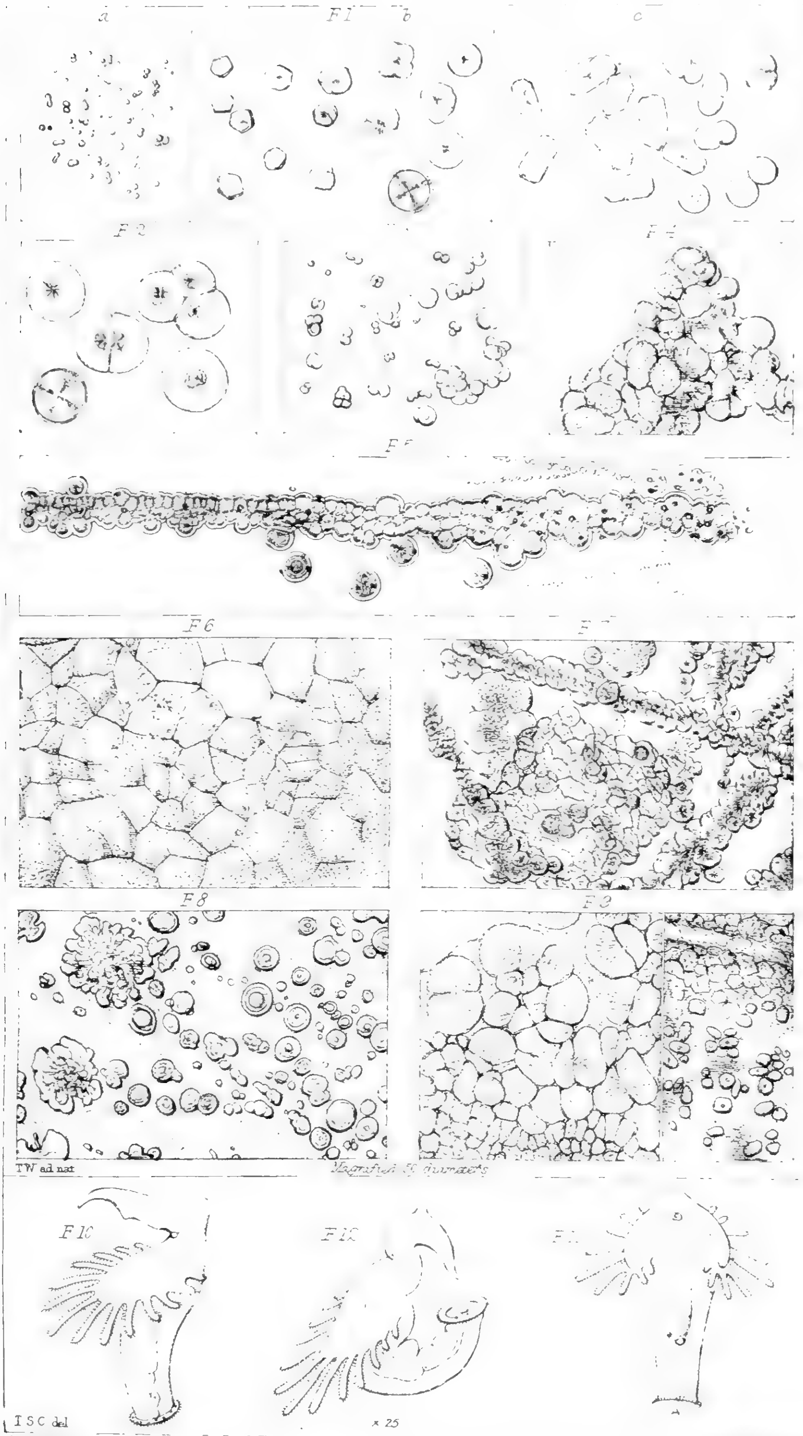
9.—*Rhizosolenia alata*, n. sp., from a sketch by Mr. G. Norman, of Hull.

a. „ portion of another frustule, original sketch.

The figures all magnified 400 diameters, except those taken from Ehrenberg.







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ORIGINAL COMMUNICATIONS.

NOTES on ARACHNOIDISCUS, PLEUROSIGMA, AMPHIPRORA, EUNOTIA, and AMPHORA. By G. A. WALKER-ARNOTT, LL.D.

ARACHNOIDISCUS.—Since my observations on this genus were published in the last number of this Journal, at p. 160, my attention has been called to the 'Annals and Mag. of Nat. Hist.,' for 1848, vol. i, p. 393, in which there is a translation of Ehrenberg's paper on *Hemiptychus.* I am likewise informed by another correspondent that it was published in the 'Berlin Proceedings' for 1848, p. 7. I have not access to the original, but from what is said in the translation, it is clear that Ehrenberg got his specimens from Mr. Topping, of London; and as it is generally well understood that the *Arachnoidiscus* was obtained by Mr. Topping from Ichaboe guano, the suspicion I threw out is verified. Whether it was certainly from Patagonia, that the Danish vessel Waldemar (spoken of by Ehrenberg) brought its cargo of guano, I know not; Ehrenberg understood this, and his information may have been correct, although doubts arise from the following considerations. From that guano Ehrenberg obtained the diatom which he has called *Entopyla australis,* for which he quotes as a synonym his former *Surirella* (?) *australis;* now my impression, from studying attentively his generic character, is that the *Entopyla australis* is the same as my *Eupleuria* (or *Gephyria*) *incurvata,* which is from Ichaboe and Saldanha Bay guano; while his *Sur. australis,* from the Falkland Islands, and not, I believe, from guano at all, is probably my *Eu. ocellata.* But it is almost impossible to determine this point without seeing perfect specimens.

I may add, that I am now informed by M. De Brebisson, that the single frustule of *Arachnoidiscus,* which he detected on *Sphacellaria olivacea,* sent him by Mr. Ralfs, and which is the authority for that genus being British, belongs to *A. ornatus,** and is therefore the same as from Ichaboe and the Cape. As the species of this genus, like other diatoms, are gregarious, the discovery of only one frustule seems to indicate some error about its title to a place in the catalogue of British genera.

* Ehrenberg's specific appellation was *ornatus;* such (and not *formosus*) is the name which I obviously intended to give to the second *Arachnoidiscus* at page 162, about the middle. This readers will please to correct.

Pleurosigma.—I find from some correspondents that the remarks I made in the last number of the 'Microsc. Journ.,' p. 164, have conveyed more than one erroneous impression. I had no intention to find fault with any gentlemen supplying Dr. Donkin with the information they gave; they got the information from friends in a perfectly legitimate way, and furnished it as legitimately, although from not coming directly from myself, it was partly incorrect and partly misunderstood. Had Dr. D. applied to me, I would have at once explained to him how the diatom in question came to be referred to *Amphiprora;* and then, I have no doubt, the paragraph at p. 33, which appeared to me uncourteous, would not have been written. Mere MS. trivial names are, by common consent, referred to every day; but unless the giver has himself published his reasons for such names, whether generic or specific, they are quoted without note or comment, and solely as provisional ones or synonyms; a departure from this would imply a right to give to the public information not intended for it, and which was obtained privately. This right, however, happily does not exist;* for if it did, it would destroy all friendly intercourse by letters.

The synonyms I gave were less with the intention to criticise Dr. Donkin's new forms, as to show that others had been engaged also on several of the same; and that in the present dislocated state of this branch of science, (now that we have lost Professor Smith as a common bond of connection,) it is desirable that before any one publishes new or supposed new British species, he should make extensive inquiries among diatom collectors, so as to discover if the same have not previously occurred to them, but perhaps under a slightly different form, and if the difference cannot be explained by extrinsic causes. By submitting the diagnosis, and taking the opinions of several, naturalists as well as microscopists, students of cause as well as those of effect, a person is more likely to come to a correct conclusion than by trusting to oneself, or consulting those only who are likely to agree with him; at all events, the species is thus amply discussed before publication, and not left to after-criticism. Some of the synonyms I adduced (at p. 165) are not published, and although the species have been long known and in many of our cabinets, and although probably Dr. Donkin would have adopted such MS. names, so far as they were

* See, in regard to private correspondence, 'Notes and Queries,' 2d series, vol. v, pp. 47, 76.

eligible, had he been aware of them, still those names which he has given, that are accompanied by a clear diagnosis, have now the right of priority.

In my remarks I mentioned that the figure of the F.V. of *Pleurosigma lanceolatum* could not belong to it; I have since received a specimen of this through the kindness of Dr. D., and to me the striæ appear horizontal, while those of *P. lanceolatum* (S.V.) are diagonal. As to what *P. lanceolatum* itself is, different observers are entitled to hold different opinions; Mr. Roper's *P. transversale* β is, I believe, allowed by all to be identical; and if I do not coincide with him, it is solely because there seems to me more points of dissimilarity from, than of resemblance to, *P. transversale*. Taking into consideration that *P. æstuarii* is "frequently direct," and that what Professor Smith would have called the "type" of that species has the ends "somewhat produced" or apiculate, and also the striation, I am almost satisfied that *P. lanceolatum* is a form of it peculiar to clean sand; but as yet neither *P. lanceolatum** nor the apiculate state of *P. æstuarii* have occurred, so far as I know, sufficiently isolated to allow of any positive deduction being drawn. What is considered the non-apiculate state of *P. æstuarii*, has been got copiously in some gatherings; but that chiefly differs from a small form of *P. angulatum* by the slightly more difficult striæ, and may be considered one of a numerous group of intermediate diatoms, none of which can be referred with certainty to any species as at present (too stringently) limited, and yet are destitute of any marked peculiarity to permit of a separation,—a group that will ultimately cause the union of several "*test species*" of that genus. The *P. lanceolatum* of Dr. Donkin must not be confounded with Mr. Norman's species of the same name, (noticed, but not defined, in the 'Ann. of Nat. Hist.' for 1857, vol. xx, p. 159); this last does not seem to me distinct from small forms of *P. strigosum*, Sm.† I referred *P.*

* I have the same form from Cumbrae in the Clyde, accompanied by *Toxonidea insignis* and *Gregoriana*, and *Pleur. angulatum*. If *P. lanceolatum* be distinct from *P. æstuarii*, it is to it that *Tox. insignis* may be referred; but I cannot indicate any marks by which the anomalous state of each is to be recognised, except by the normal form which accompanies it. *Tox. Gregoriana* I refer to the sand form of *Pl. angulatum*.

† I may here mention that "*P. strigosum*" seems to have been adopted by Smith on the supposition that the Hull *Nav. strigosa*, of Harrison, was the same; this, however, I have ascertained, is not the case. *N. strigosa* of Harrison and Sollitt ('Micr. Journ.,' ii, p. 62), is *P. angulatum*, Sm.; while their *N. angulata* is *P. quadratum*, Sm.; their *N. lineata* is *P. elongatum*, Sm. It is not, however, improbable that these and some others form a single species.

Wansbeckii, Donk., to *Amphiprora Ralfsii*; the examination of a specimen from Dr. Donkin satisfies me that I was wrong, and that it is a true *Pleurosigma*, and the same which Smith has called *P. Balticum* β; I learn from Mr. Roper that his opinion quite coincides with my own. This also is the same which is called *Navicula scalprum* by Kutzing, as far at least as regards the form found by De Brébisson (see 'Kutz. Sp. Alg.,' p. 85); and it may be the same as that figured by Kutzing (Bac. tab. 30, fig. 13), from Trinidad, and since called by him *N. Scalpellum*, but it scarcely agrees with the figure of *N. scalprum* given by Gaillon and Turpin (who first gave the name), in the 'Mem. du Mus.,' xv, t. 10, fig. 3, and which figure is copied by Kutzing (Bac. tab. 4, fig. 25), and appears rather to indicate *P. Hippocampus*, Sm. In *P. Balticum*, β and γ of Smith, the striæ are as numerous as 64 or 65 in ·001; and from notes before me I find that some others raise that number to 85; this creates a doubt if these two varieties ought not to be separated from a species which has only about 38. I believe that the usual state of *P. Balticum* is scarcely or not at all found at Hull, whilst the var. γ occurs copiously at Hessle, and sparingly in several other places in that neighbourhood; this, however, by itself, affords no valid reason for the separation, any more than that the mixture of all the three would prove them only to be varieties of the same species.

AMPHIPRORA.—The verbal distinction between this genus and its cognates *Navicula* and *Pleurosigma* is so slight as to be easily passed over. It is unnecessary to refer to Kutzing's generic character of *Amphiprora*, which is obtained from the Front View only, while that of *Navicula* (including *Pleurosigma*) is derived from the Side View; "the so-called wings (*alæ*), or projections (as has been remarked by Meneghini), belong to the secondary surfaces (S. V.) and constitute the only distinctive character of the *Amphiproræ*." By comparing Smith's analytical table at p. 9 of vol. i. of his 'Synopsis of Br. Diat.,' with the characters given at pp. 43, 46, and 61, it will be seen that his views are that in *Amphiprora* the F. V. of the frustule and valves is deeply constricted laterally, while the valves, or S. V., are furnished at the median line with a ridge or keel; in the two others, on the other hand, the F. V. is without a conspicuous constriction, and the valve is plane or convex merely, and the median line destitute of a keel. There is thus a double character, and when the one is not very decided the other may be taken as a guide. I

believe that Smith's views are now almost universally adopted; at the same time there are some cases which require careful consideration.

Pleurosigma is said to have sigmoid valves, that is, flat, but bent laterally in the same plane, at the one end, in a different direction from what they are at the other. In *Navicula* the opposite character is not given, but is implied. In *N. Jenneri* and *N. convexa* the valves, at first sight, appear to be sigmoid; but the cause of this is easily understood by examining the F. V.; from it, it will be seen that the entire frustule is not simply bent to the right or left, but has a slight spiral twist; so that when the valves are separated they do not lie flat, and the result is the apparent sigmoid median line: had the valve not been twisted, the median line would have been perfectly straight and central. In *Pleurosigma* I have seen no instance in which the living frustule is twisted;* "the F. V. is either of a linear, or linear-lanceolate, form" (Sm.), and the S. V. is sigmoid, with the median line nearly equidistant from the two sides; but after the valves are detached from the connecting zone they often become slightly twisted, and as they cannot then present a flat surface to the eye, the median line appears to approach nearer to the one margin than to the other. How far the amount of this inequality can be relied on for the distinction of species is doubtful; *P. decorum* is principally separated by Smith from *P. formosum* by such an appearance. I am not aware that this twist has been seen except in those species which have oblique striæ, and it may be dependent on that structure.

In *Amphiprora* the median line in the entire frustule is usually straight, and when not so this arises from the torsion of the frustule; in *A. alata* and *A. paludosa* the frustule presents both appearances, as shown at fig. 124 *b*, and *b'*, and fig. 260 *b*, and *b'*, of 'Smith's Diat.' I have not, however, myself detected the twisted form in these while the diatom was alive, and it is often not so even after being dried, or maceration in weak acid. When the valves are separated from the connecting zone, their tendency to assume the spiral form is much more striking, as exhibited by Smith

* I have not myself the F.V. observed of the living frustule of any of the anomalous or distorted states which form the genus *Toxonidea* of Donkin; of these states I have seen five, one I would refer to *Pleur. æstuarii*, a second, if distinct, to *P. lanceolatum*, a third to *P. transversale*, a fourth to *P. angulatum*, and the fifth to *P. strigosum*. The third of these I have detected lately, but of it only one frustule; the others I have already noticed (p. 165).

in his fig. 124 *a*, and *a′*; when this occurs the median line, formerly straight, becomes also spirally twisted.*

The genus *Amphiprora*, as appears to me, may be readily distinguished from *Pleurosigma* by attending to these considerations. The extreme thinness of the connecting zone in the latter renders it almost impossible to obtain a F. V., unless in fluid agitated by a drop of spirit of wine, while in the former the F. V. is readily detected, the connecting zone being of considerable breadth; in *Pleurosigma* the F. V. is less in breadth than the breadth of the valve, while in *Amphiprora* it is generally the reverse.

I have not seen any *Amphiprora* with the principal or coarser striæ oblique, although, from the facility of torsion in its valves such instances may occur. But as all diatoms, with striæ composed of dots, have four rows of striæ, two diagonal, one horizontal, and one longitudinal; and as the visibility of each depends, when delicate, on the position the valve presents to the illuminating oblique pencil of light, the closer or more difficult striæ are sometimes seen when the others are not, and thus may be occasionally mistaken for the predominating or coarser ones, which alone are made use of in specific characters. I may here remark that when the dots are placed so as to form rectangles, the transverse and longitudinal lines are always the most remote, and therefore predominate; and it is generally supposed that, when the dots are quincuncial, the diagonal lines are always most apparent; but this conclusion is not correct, for when the diagonal lines make, with the transverse, an angle greater than 60°, the transverse rows are more remote than the diagonal, and when the angle is less than 30°, the longitudinal rows are the more remote and easily detected. In the quincuncial structure, therefore, the diagonal lines predominate only when the angle of inclination is more than 30° and less than 60°; but the transverse and longitudinal cannot both preponderate in the same species.

To distinguish *Navicula* from those species of *Amphiprora* which have the frustule straight and no *alæ*, is considerably more difficult, and I doubt if there be any characters more readily available than those mentioned by Smith, viz., the con-

* The facility of twisting and the amount seem to depend on the smaller or greater quantity of silex assimilated by the frustule; and this again, in all diatoms, varies in the same species according to the vigour of its growth, arising from locality, season of the year, and other incidental causes. Our whole knowledge of these beings is as yet in an embryo state, and will be best promoted by extensive morphological observations on species about which all are agreed; till then the limiting characters of species, and the species themselves, must be very unsatisfactory.

stricted frustule and carinate valve or median line; the first of these is not to be much relied on, as it is exhibited slightly in some species of *Navicula,* while it is observed only in a modified manner in *A. vitrea.* In this species, and also in *A. elegans,* there seem to be frequently four valves to the frustule; I have seen the same structure in *Schizonema cruci-gerum, Pinnularia major, lata, alpina,* and some others, but it is accidental and not characteristic of such species.

Dr. Gregory, in his paper on 'Clyde Diatoms,' introduces into the descriptions of some of his forms, a notice of a "plate" which is said to be *above* the valves; he does not seem to consider its occurrence as universal in the genus, but characteristic of certain species only. How these plates are formed or attached I do not understand. I am not aware that they have been seen separated *from* the valves, and if a peculiarity of structure *of* the valves, they ought to be traced in these. Although, however, I have attempted to model in clay or putty a frustule with the valves as figured and described, connected by a zone, I have not succeeded in constructing anything like these plates. That there is such an appearance is unquestionable, so that a suspicion arises that such plates do not lie *above* the valves, and indeed have no actual existence, but that the whole arises from our seeing the margin, or the surface outline of the valve, through the medium of part of the frustule. If proved to be actually external and above the valves, or to be caused by any other difference of structure from what is usual in the genus, its importance as a specific distinction will be readily allowed.

I exclude, at present, from the genus the curious and perfectly distinct *A. complexa* of Dr. Gregory. As the slices are not perforated, they cannot be annuli, such as occur in *Rhabdonema;* and if entire lamina of the connecting zone,* an obscure affinity with *Rhipidophora* would be established. The true structure of this diatom, and therefore its genus, is however quite uncertain.

* In various species, particularly marine ones, of different genera of diatoms, as *Navicula, Amphora, Amphiprora,* and *Schizonema,* the connecting zone exhibits frequently a lamellar structure, the number and appearance of the lamellæ varying much in the same species according to circumstances. *Navicula Libellus* of Dr. Gregory, on that account, seems to be the well-known and not uncommon state of *Schizonema Grevillii.* When these lamellæ are perfect, the frustule is necessarily divided by them into two cells, a proof that it is then undergoing self-division; but the cause of this appearance, or why it is not to be detected at all times in the same species, is unknown to me. Several, if not all, of Dr. Gregory's group of "complex Amphoras" are in this predicament; at least in these the lamellæ are not described and figured as annular or with a perforation, as would be were the zone not in the variable or transition stage, and thus unsuited for specific distinctions.

Eunotia.—To define this genus appears to have caused Professor Smith some trouble; at first his intention seems to have been chiefly to distinguish it from *Epithemia*, with which it was combined by Ehrenberg; but in his second volume, under *Himantidium*, he proposes to introduce the radiating striæ as a character. One of his species (*E. arcus*) may be left out of consideration, as this grows attached to small algæ, by the end, by means of a "cushion-like pedicel," as in *Synedra*, to which genus it belongs; indeed, when I met with it, in that state, near Brodick, in Arran (July 1854), it was so closely intermingled with *S. pulchella* and *S. gracilis* that I then felt disposed to consider it a deformity of one of these. In all the genuine species of *Eunotia* which I have examined previous to or after a very slight maceration in acid, I find the portion called the valve by Smith to be more composite than can be inferred from his figures, each being made up of parallel slices or lamina, easily observed in the F. V.; and I have been so unfortunate as never to see the connecting zone as represented: indeed, had Mr. West's accuracy not been beyond suspicion, I should say, as the result of my own observations on recent gatherings, that this broad zone did not exist, and that the supposed single valve was composed of several valves, each separated by a very slender and almost invisible zone. I therefore, at present, consider each supposed valve to be formed of a series of frustules, and that the connecting zone figured in Smith's work is some accidental enlargement of one of the slender connecting zones. Be that as it may, the divisibility of the supposed valve into several is perfectly different from what has been seen in the genus *Himantidium*, where the valves are incapable of dividing, and are separated by a siliceous zone of considerable breadth. This structure at once enables us to remove *E. gracilis*, Sm., (although the frustules are often solitary) to *Himantidium*, under which genus the small state of it had been previously described by Kutzing as *H. exiguum* of De Brébisson.

Amphora.—Some friends having expressed a wish that I should explain my views of the structure of the genus *Amphora* more fully than given at p. 184 of this volume of the 'Micr. Journ.,' I subjoin the following extract from the paper as originally prepared.

Kutzing's ideas of the structure of this genus are not very clear. If we compare his description of it with that of *Navicula*, and suppose that in the former he has mistaken the *Front* for the *Side* view of the frustule, the characters of both will scarcely differ, and his views would thus be much the same

as my own, which, indeed, occurred to me from supposing Kutzing's observations to have been misprinted. If, on the other hand, he has not inverted these, he must have looked on the frustule as a hollow spheroid, and that planes passing longitudinally through the central nodules and the eye, would cut off the valves. Smith has obviously understood Kutzing in this sense, and although some expressions and his figures would seem to indicate that he was not altogether satisfied on the subject, he adapted his generic character to it, and described each valve with the central nodule marginal; in this way the whole portion between the median lines must be considered as the connecting zone. But that such cannot be its real structure is obvious: 1st, from there being a deep groove or hollow in front: 2nd, from the sides of this groove, nearly up to the median line, being striated precisely as on the other side: 3rd, from the median line forming a ridge; the first of these is best seen by putting the entire frustule, before being macerated, into balsam; the two last require us to examine it obliquely when not in balsam. The anterior margin of the valves, where they are attached to the connecting membrane, is thus not close to or on a level with the nodule, but considerably farther from the eye, closer to and more directly above the posterior margin.

The form of the frustule of *Amphora* may thus be compared to that of a coffee-bean, rounded on the back and hollowed out in front, a transverse section being somewhat reniform or lunate. If we take two circular pieces of paper, gum them together by their edges, and mark this disk on the margin, with two dots of ink at the extremities of a diameter which is at right angles to another which may be supposed the axis or line of self-division; the dots will represent the central nodules, and the edge of the disk the median line; a diatom like that would only differ from the genus *Navicula* by the valves being much folded or *compressed*, while in *Navicula* they are usually nearly flat or *depressed*. If we now bend up the sides of the disk, so that the central nodules approach each other, this will in some degree represent an *Amphora*, the only difference being that in the disk the curves of both surfaces are almost parallel, the one concave, the other convex, while in *Amphora* the anterior or concave one is usually smaller than and of a different kind from the posterior. In *Amphora*, then, the median line, as that ought to be called which connects the central with the subterminal nodules, although apparently marginal, is similar to what is observed in other Diatomaceæ in which nodules exist; indeed, this genus only differs by the portion of each valve on the one

side of the central nodule being smaller and differently curved from that on the other, whereas, in most genera of the group, these two portions are alike.

The incurvation of the valves is at its *minimum* when they are in the incipient state, at its *maximum* when the frustules have separated after self-division. The proximate cause is the contraction of that half of the valves which in the disk of paper is next the eye, and its consequent thickening, for the quantity of silex is probably the same on both sides; but the cause of the contraction I cannot explain. By this bending in of the valves the central nodule, which was apparently marginal, now assumes a position sometimes nearly vertical to the line of fission, but sometimes reaching to only one fourth of that distance. The *maximum* incurvation and also the projection of the median line on the plane of the field of view (a line of double curvature) vary in the same species, although generally within certain limits. The true form of the valve would be nearly got by completing the apparent outline by the addition of the incurved part; but the apparent outline of the frustule itself, at the *maximum* incurvation of the valves, is found to be more easily observed and convenient for description; and to this, there is no objection, if those frustules only be used in which the connecting membrane is at its *minimum* breadth. The striæ on the valve are precisely alike on each side of the median line, but from some being seen through the medium of the valves, and others presenting themselves directly to the eye, the former appear faint and hazy; the latter, between the median line and the outline, are therefore alone referred to, in their definitions, by the more eminent diatomists. From the minuteness of the object, its inequality of surface, the necessity of using high powers and these with a large angle of aperture, it is impossible to bring all the parts into view, without altering the focus, or to give a perfectly accurate representation of the structure except by models.

The portion separating the two valves, or the connecting zone, varies much in all diatoms, but more so in *Amphora* than in most other genera. At first it is narrow, then it becomes broader and broader, but is in most species striated very differently from the valves, if striated at all.* The new or intermediate valves, which it projects, are at first destitute of

* The circumstance of the structure of the connecting zone being the same, or very different from that of the valves, indicates two groups or sections of the genus. As this is quite independent of self-division, it is of more importance than the splitting of the connecting zone into several plates, at least until the cause of this be ascertained.

silex and imperfectly seen, then they become more and more conspicuous and siliceous, rapidly altering in shape and position; the primary valves also alter in position, but not in form. The central nodules of the two new valves appear now at the back, nearly where the connecting zone formerly was, while the back of each half of the double frustule is removed to the side, or is placed right and left of the spectator's eye, instead of directly before him; thus each half of the twin frustule occupies a position at right angles to what the parent frustule did, and which the perfect separated one ought to do. Finally, the two portions of the double frustule separate from each other in front like the two valves of a mussel-shell; the amount of separation depending on the strength of the remains of the siliceous band that connects them, and causing the general outline to vary extremely. In characterising or figuring the *forms* of this genus, it is therefore necessary, for the sake of comparison, that each be viewed under *precisely* the same circumstances; moreover, so many changes take place whilst the process of self-division goes on, that no descriptions or figures are of much use in the identification of permanent forms or species, unless when taken from the simple but perfect frustule before self-division commences, or from its valves.

Although the structure of the genus adopted by Kutzing and Smith be not what I conceive the correct one, no practical inconvenience arises, as their specific characters have been selected from the same parts on which they must otherwise have relied. It is, however, somewhat different with that given by the late Dr. Gregory in his paper in vol. xxi of the 'Trans. of the Royal Soc. of Edinb.' p. 510; but here I experience considerable difficulty from his having introduced into his descriptions several terms, neither employed by any other writer, nor explained by himself, the meaning of which the reader is left to discover. From a careful comparison of the figures, I presume that by "ventral margin" he intends sometimes both the anterior and posterior margin of the folded valve, and sometimes the irregular margin of a portion of the still adhering connecting membrane; by "dorsal margin," the outline of the frustule; and by "inner curve line," the median line of the valve; most of which vary in appearance according to the position presented to the eye by the frustule during self-division. There are other terms, however, about which I am more doubtful; as "inner margin," "outer margin," and inner or outer "compartments of the valves;" although it is probable that all, in some way, refer to the connecting zone. Dr. Gregory's theory is, that "what is

usually called the entire frustule" consists of "two frustules in the act of self-division," and consequently of *four* valves, and it results from this that what is commonly called a single frustule is composed of two new valves, forming or formed, in addition to the two primary ones; in short, that the small portion seen in front alone belongs to the original frustule. If we now take what is usually called a double frustule (as in Smith's fig. 28 *d*), which by Dr. Gregory's theory must consist of four frustules or eight valves, three-fourths of the whole must be either in the transition state, or represent six valves, each identical with the two original ones, but in a different position. As I cannot suppose that Dr. Gregory intended to take distinctive marks from the connecting zone in its variable state, or from more valves than one, or from their accidental relative position, it appears to me that his hypothesis, if correct, would much increase the difficulty of finding constant characters, and cause the rejection of several on which he depends, as well as the annihilation of many of his new forms.

I may here mention that *A. marina* of Smith, alluded to by Dr. Gregory under his No. 76, is precisely what Dr. Gregory calls *A. Proteus*. Smith's figure ('Ann. of Nat. Hist.' for 1857, vol. xix, tab. i, f. 2) is far from good, and represents the double frustule towards the close of the self-dividing process. Some years ago Smith gave it the MS. provisional name of *A. Scotica*, from its having been first detected on the west coast of Scotland by Mr. Hennedy of Glasgow; he omitted it in the second volume of his 'Synopsis,' being not quite satisfied with its claims to be specifically distinguished from *A. affinis*; but these doubts were removed by afterwards finding it in the summer of 1856 near Havre and Biarritz, on the French coast, and thus having an opportunity of studying it in the living state, and drawing up a specific character.

On some British Fresh-water Algæ.

By Frederick Currey, Esq., M.A., F.R.S.

The observations to which this paper relates were made in the year 1856, and have since been laid by under a doubt as to their being of sufficient importance to be made public; but some recent observations in Germany have induced me to think that they may not be without value, especially if they should have the effect of directing the attention of some of the numerous microscopists of the present day to the abundance of material for interesting and important microscopical inquiries afforded by the fresh-water *Algæ*.

The first matter to which I wish to direct attention is a peculiar condition of fructification of the common *Draparnaldia glomerata*. When this plant is taken from the water, it presents, as is well known, a shiny gelatinous mass of a uniform yellowish green colour, and without the aid of the microscope it is impossible to trace its structure. In the month of April, 1856, I found, in a pool of water in a gravel-pit in Cobham Park, a quantity of *Draparnaldia glomerata*, in which the jelly was traversed by multitudes of dark-coloured feathery-looking lines, clearly visible to the naked eye, and upon examining it with the microscope, it appeared that almost all the side shoots of the Alga had become transformed into rows of globular brown cells, arranged in a moniliform manner. These cells were, in most instances, in close contact with one another, but here and there single cells were to be seen, which, although isolated, clearly belonged to the same congeries. It was obvious that these brown cells had been originally formed in the interior of the joints of the side shoots of the Alga, and were, at the time of the observation, gradually becoming free by the dissolution of the walls of the parent cells, the debris of which helped to form the gelatinous medium in which they were immersed. Fig. 1 represents the general appearance of a portion of the plant under a power of 200 diameters. It will be seen that at one point, at the extremity of one of the shoots, the formation of the brown cells is not complete, the three terminal cells, retaining still their primary oblong form and their original pale green colour. I am not aware that this state of fructification in Draparnaldia has ever been described. The ordinary mode of reproduction of this Alga is by zoospores, which are emitted from the cells of the ramuli, and which are of a sub-globose or elliptical shape, and furnished with

four cilia. I find in the 'Regensburg Flora' for 1855, a description of the fruit of a Draparnaldia, published in Rabenhorst's collection, which is probably of the same nature as that which I have described above; the notice in the 'Flora' is very short, and speaks of the specimen as being a curiosity on account of its fruit.

There can, I think, be little doubt that these brown globular cells are of a nature similar to that of the orange-coloured cells of Volvox, and the red cells of Bulbochæte, Chlamydococcus, and other Algæ; that is, that they are the resting cells, or, as they are sometimes called, winter spores, capable, as all such spores are, of undergoing desiccation for a lengthened period, and reviving again when circumstances become favorable to their development.

I kept the bottle containing the Draparnaldia by me for some weeks, at the end of which time most of the brown cells had disappeared, and the water contained a mass of green Algæ, which, at first sight, might have been supposed to belong to the genus Glæocapsa, but which appeared to me to have originated from the division of the contents, and from the softening and consequent enlargement of the outer membrane of the brown cells of the Draparnaldia.

If these Glæocapsæ originated in the manner I suppose, the contents of the brown cells must have changed their colour during the process, but this, as is well known, is by no means an uncommon occurrence in the fresh-water Algæ, when entering upon a new phase of vegetation. Not having had leisure at the time to follow out the process from day to day, I cannot state positively that the Glæocapsa-like Algæ originated in the manner above mentioned, but it can hardly be doubted that such was the case, and the point is one which may afford matter for interesting investigation to any microscopist who may happen to meet with the Draparnaldia in the state of what may be called its winter fructification.

The Glæocapsæ, if I may so call them, which resulted from the division of the contents of these resting cells of Draparnaldia, consisted each of a gelatinous envelope enclosing a number of small motionless green cells, or gonidia. In the oospores, or spores formed after copulation, of Spirogyra, I have seen the cell-contents divide into a number of round motionless cells, *quite devoid of colour*, and I have seen a similar process in one of the large orange-coloured spores of the so-called *Volvox aureus*, which is only the resting form of *Volvox globator*, where the contents divided into five globular colourless cells, which floated in a mass of reddish plasma, being apparently the remains of so much of the original

contents of the cell as had not been absorbed in the formation of the secondary cells.

There is, however, another mode of self-division where the spore, or resting cell, divides first into two and then into four segments, each segment being the counterpart of the original, which thus produces a new generation of resting cells. This latter mode of division has been supposed to take place in the red resting cells of Chlamydococcus; but it has been recently stated by Professors Cohn and Wichura that this case requires further proof. I am enabled to furnish some evidence on the point, for I have distinctly observed the process of self-division in some red resting-cells, which were probably those of Chlamydococcus. I say *probably*, because the red resting-cells of Chlamydococcus are quite undistinguishable from those of another of the Volvocineæ, viz., *Stephanosphæra pluvialis*, so that without following out the development it is impossible to predicate whether such red cells belong to the one or the other.

Pl. IX, fig. 2 shows an instance in which one of these cells has become divided into two parts; and Fig. 3, an instance in which the self-division has gone further, andthe original cell has become separated into four secondary cells, each precisely similar to the primary one.

In a recent paper by Cohn and Wichura, published in the Transactions of the Bonn Academy, and an abstract of which appeared in the last number of this Journal, a question of some physiological interest has been raised with regard to the nature of these red resting cells. They observed that these cells in *Stephanosphæra pluvialis*, which are at first of a green colour, and furnished with cilia, increase in growth after the green colour and the cilia have disappeared, *i. e.*, after they have assumed a state of rest, a fact which they consider to militate against their character as spores.

"We have seen," they say, "that these resting cells, after they have been formed by the metamorphosis of a motile primordial cell, increase in growth considerably; that they go through a further vegetative development, and have, therefore, not reached the termination of their vital process." And they then add: "It is contrary to the idea of a spore, that it should continue to grow after having assumed the character of a resting cell, and the fact has never yet been observed in any single case." It would seem that these remarks are intended to be limited to the Algæ; but it is worthy of observation, that the spores of the ascigerous Fungi frequently increase in growth, after escaping from the asci, and if this circumstance is not to be looked upon as affect-

ing their character as spores, it is difficult to see why a different rule should be applied to the Algæ.

Cohn and Wichura moreover consider that the increase by self-division is irreconcileable with the idea of a spore. In speaking of the red cells of *Chlamydococcus pluvialis* they express a doubt whether, in those cells, increase by self-division takes place, but assert, that if such should prove to be the case, it would be conclusive against their being spores, considering self-division (if I understand them right) to be a process of vegetative development distinct from germination. These observations are worthy of the careful attention of microscopists, and without venturing an opinion as to their correctness, I would only remark, that if the resting cells of Chlamydococcus and Stephanosphæra are not to be considered spores, that character must also be denied to the resting cells of Œdogonium, Bulbochæte, Draparnaldia, Sphæroplea, and Volvox, if, as is more than probable, there should be detected in these latter cells,—1st, an increase in growth, after becoming quiescent, or, 2dly, increase by self-division.

2. I now proceed to notice some minute parasitic organisms, which will be best dealt with by simply describing them, inasmuch as it is impossible, with any certainty at least, to assign them a definite place amongst the fresh-water Algæ. Their form is that of small globular vesicles, furnished with a stalk, the length of which is sometimes about equal to the diameter of the vesicle, sometimes considerably greater. I have observed them growing upon zoospores, and also upon the large oval resting spores of a species of Spirogyra. The zoospores were of a bright green colour, and of rather a small size, as will be seen by refering to fig. 4, which represents one of them magnified 220 diameters, and with the parasites attached. The latter are quite colourless, and the globular head exhibits a well-defined nucleus. The zoospores upon which they grew were in the most active motion, revolving first in one direction and then in another, looking and as if they were attempting, by the rapid changes of their movements, to shake off and rid themselves of the incubus of the parasites. Not having seen the zoospores in their parent cell, I am quite unable to say from what plant they were produced. The number of the parasites on the zoospores was variable, not, I think, exceeding five or six on any one zoospore; but, in the case of the Spirogyra (fig. 5), they grew so thickly as almost to conceal the spore, the individuals being precisely similar in form and appearance to those on the zoospore. Should these bodies come under the notice of any of the

readers of this Journal, I would venture to express a hope that they may be carefully watched. It is not, I think, improbable that they may prove to be undeveloped forms either of some species of Chytridium or Rhizidium, or of the genus Pythium; but without following out their development, this point cannot be decided. The only plant I know which at all resembles them is *Chytridium apiculatum* described in Dr. Braun's monograph of the genus Chytridium, and figured by him in Pl. V, fig. 10, of that monograph; but it will be seen, by comparing his figures with fig. 4, above referred to, that there is a marked difference in form between his species and the present organisms.

Pythium is a genus separated from Achlya and Saprolegnia, by Dr. Pringsheim, in his paper on the Saprolegnieæ, in the last part of the 'Jahrbücher für wissenschaftliche Botanik.' The distinctive features of the genus are—1st, that the contents of the sporangium are ejected before the formation of the zoospores, and out of the mass thus ejected, but which adheres to the sporangium, the zoospores are subsequently developed; 2dly, that the oogonia, or spore cases, produce only one resting spore, instead of several, as is the case in Saprolegnia and Achlya.

I have stated that the parasitic Algæ just described were attached to a species of Spirogyra, and I may mention (as it has not been often seen), that several of the resting spores of the Spirogyra, to which the parasites were *not* attached, commenced germination during my observations. The germination of these spores is a matter of some interest. It was first mentioned by Vaucher fifty years ago; afterwards Dr. Hassall, in his 'British Fresh-water Algæ,' considered Vaucher to have been altogether mistaken; but some years later the germination was again noticed by Dr. Pringsheim and by the late Professor Smith, and the correctness of Vaucher's observations placed beyond doubt. In figs. 6, 7, 8, and 9, Pl. IX, I have drawn some of these germinating spores. At the period of germination they consist of three membranes, the inner one enclosing the cell contents, which become green just before the germ breaks forth. In fig. 7, the outer membrane, which is seen loosely attached, was colourless; the second membrane, which (see figs. 7 and 8), has opened, to give exit to the germ, was at this period of a pale brown colour, and transparent. In fig. 8 the young germ has become three-celled, and there is a slight tendency in the endochrome to assume a spiral form, and the remnant of the spore is still attached. In fig. 9 the germ has become free, and the endochrome more visibly spiral.

3. The next plant which I have to mention, is one which has not hitherto been observed in this country.* I have only found a single specimen, and that in a young state, but there is no difficulty in identifying it with the species described by Dr. Braun, in his 'Algæ unicellulares,' under the name of *Sciadium arbuscula*. This *Sciadium arbuscula* is an Alga of very singular growth. It consists, in its first stage, of an erect cylindrical elongated cell, furnished with a very short narrow stem at the base. The endochrome of this cell breaks up into separate portions and forms, from five to ten, usually eight, gonidia, arranged at first in a single row. Afterwards the apex of the cell opens by a circumscissile fissure, and the gonidia protrude through the orifice and form an umbel of cells. The cells forming this umbel grow into elongated cylindrical cells, precisely similar to the parent-cell. Their stems are united into a fascicle just inside the mouth of the tube of the mother-cell, but are not long visible, owing to a dark-coloured secretion, which forms round the bases of the cells at an early period of their growth and completely obscures the stems. The branches of the primary umbel produce gonidia, which go through the same process, and thus secondary umbels are formed, from which, in process of time, tertiary umbels are produced. The gonidia which are formed in the branches of the tertiary umbels, instead of remaining united at the apices of the branches, escape from their mother-cells, but it is not certain whether they emerge in the form of zoospores, or as motionless cells. Dr. Braun has not observed their actual escape, but has seen zoospores agreeing in size and form with the gonidia of Sciadium moving about, amongst the specimens of that plant, and which, in his opinion, had their origin in the cylindrical cells.

Fig. 10 represents the British specimen which occurred in a pool on Paul's Cray Common, in Kent, in the spring of 1856. The cylindrical cell was colourless for the greater part of its length, but the tip was almost black, having, however, a reddish tinge, the colour being so dark as quite to obscure the stems of the transparent green gonidia, which protruded, eight in number, from the apex of the mother-cell. I did not see the short filiform stem noticed by Dr. Braun;† but, on referring to his figures, it will be seen that

* I have this spring observed two more specimens in water from the same locality, both in the same stage of growth as the one described in the text.

† This stem was plainly visible in the specimens which occurred this year.

this stem is very short, in comparison with the length of the cell which it supports, and might easily be concealed by the body to which the Sciadium was attached. *Sciadium arbuscula* forms an interesting addition to our British fresh-water Algæ.

4. *Pandorina Morum*, Ehr.—This plant was described, with some other Confervoid Algæ, by Mr. Henfrey, in the fourth volume of the 'Transactions of the Microscopical Society.' It had been previously seen by Mr. Shadbolt, and probably by many other observers; but, notwithstanding Mr. Shadbolt's remarks in his presidential address for 1856, it is clear that Mr. Henfrey was right in describing it as new to England, the test of novelty being, not whether it had been previously seen, but whether it had been published as a British Alga. In speaking of the reproduction of Pandorina, Mr. Henfrey mentions two processes—1, the conversion of each gonidium into a new frond within the parent mass; and 2, the conversion of the gonidia into encysted resting spores, which are set free, and subsequently germinate to produce new fronds. Upon this I may remark, that the process of becoming encysted does not invariably take place *within* the parent frond, for I have seen the gonidia of Pandorina escape from the parent frond in the form of membraneless active zoospores; and although I was not fortunate enough to trace the subsequent fate of these zoospores, the probability is that, like those of Chlamydococcus and Gonium, they would become encysted at a subsequent period, as without undergoing this process it is difficult to see how they could produce new fronds. This mode of escape of the zoospores seems to throw some doubt upon the suggestion of Mr. Henfrey, with regard to the nature of the frond of Pandorina, which he considers to be solid, inasmuch as it does not give way or become indented by pressure, as is the case with the hollow frond of Volvox. If, however, the frond were solid, the zoospores could not well escape except by its gradual dissolution, but, in the instance I have mentioned the escape certainly took place by a rupture (as may often be seen with Volvox), and not by a gradual process of dissolution. In a paper on some Volvocineæ, by Dr. Fresenius, in the second volume of the Transactions of the Senckenberg Natural History Society, he speaks of the easy escape of the cells of *Gonium pectorale*, as being evidence against the existence in that Alga of any firm covering, and he draws a distinction in this respect between Gonium and Pandorina. My observation, however, leads me to think that Pandorina, as far as relates to its coat, does not substantially differ from Volvox and Gonium. Besides the na-

ture of its coat, there are some other points of structure in Pandorina requiring further examination and elucidation. Ehrenberg stated that the gonidia of Pandorina have one cilium, and no eye-spot, a view adopted by Fresenius, in the paper I have alluded to. Focke and Dr. Braun considered Ehrenberg's observations inaccurate, and Mr. Henfrey agrees with them. As far as my observations go, I should say that the gonidia have usually two cilia, but that they frequently have no eye-spot. Mr. Henfrey has never been able to observe a pulsating vacuole, nor was any such vacuole visible in my specimens. Dr. Fresenius, on the other hand, has observed one, sometimes two, such vacuoles; and he remarks, that cilia and red spots are subject to considerable variation, and suggests that Stephanosphæra and Volvox are probably the only distinct forms to be met with in the Volvocineæ. I should protest against including *Gonium pectorale* in the same genus as Stephanosphæra; but, with this exception, Dr. Fresenius's suggestion is probably correct. If, however, Stephanosphæra and Pandorina are only forms of the same plant, the generic name 'Stephanosphæra' must give place to 'Pandorina,' the latter being of much earlier date.

A reference to Mr. Henfrey's figures will show how much variety exists in different specimens of Pandorina. In figs. 11—17 I have drawn several forms, all probably referable to Pandorina, which came under my own observation. Fig. 12 is a large globe, filled with encysted berry-like masses, the membrane standing out a considerable distance from the gonidia. This form was not in motion, although the cilia of the internal fronds (some of which are, from the size of the object, out of focus) were most clearly perceptible. Fig. 16 shows a similar but much smaller frond, in which the cilia were not visible. Fig. 15, a frond in which only one cilium was apparent, but I cannot state positively that two did not exist.

5. *Monostroma roseum*, n. sp.—This Alga, a species not hitherto described, seems to unite the characters of a Monostroma and a Palmella. It is to be found, usually in some quantity, in a stagnant pool at the conduit-head in the fields between Eltham, in Kent, and Halfway Street, and I have met with isolated specimens in two other pools near Shooter's Hill. All three of these pools are lined at the bottom with particularly fetid black mud, but the water itself is clear. The fronds are of a bright pink, or sometimes lilac colour, and consist in their early stage of a hollow globular membrane, formed of closely approximated cells. Figs. 18 and 19 represent two young fronds magnified fifty diameters;

of which fig. 19, by the rupture at the apex, clearly shows that the interior is hollow and not solid. A power of fifty diameters is quite insufficient to show the constituent cells, but their nature is clearly seen in fig. 22, which shows a portion of a more advanced frond magnified nearly 700 diameters. It is but rarely that specimens such as those in figs. 18 and 19 are obtainable. The membrane, instead of remaining of a globular shape, very soon becomes bent and crumpled into a variety of forms, as shown in figs. 20 and 21. The fronds are very delicate, and are apt to be put out of shape even by the pressure of the thin glass cover, and it is advisable, therefore, to examine them in a thin cell, or at all events to prevent the direct pressure of the glass cover upon them. In process of time the fronds lose altogether their membranous nature, and when full grown they consist of a gelatinous mass, with multitudes of small cells imbedded in it. By bringing the margin of a frond into focus, it is seen that the gelatinous mass extends considerably beyond the outermost cells, and a very slight pressure disperses the jelly and sets free the minute imbedded cells. The full-grown fronds are usually of irregular shape, but with a length or diameter sometimes as great as one fifteenth of an inch or even more.

It will be seen, therefore, that the Alga just described might, at one period, be classed with Monostroma, at a later with Palmella. The gelatinous mass doubtless arises from the partial dissolution, as well of the walls of the primary cells constituting the original membranous fronds, as of the walls of the cells produced by the self-division of such primary cells.

6. *Clathrocystis æruginosa*, Henfrey.—In figs. 23 and 24 I have drawn an Alga, which seems to be identical with Mr. Henfrey's *Clathrocystis æruginosa*, figured in 'Trans. Micr. Soc.,' vol. iv, figs. 28—36. It differs somewhat in the much greater number of reticulations. In this case, as in that of *Monostroma roseum*, there seems to be a transition from hollowness to solidity. In fig. 23 the frond has a reticulated structure, and having been split open by a clean fissure, has the appearance of being hollow in the interior. In fig. 24, on the other hand, the green cells seem to be imbedded in solid, soft, and colourless gelatinous matter. Fig. 25 shows a mass of the component green cells; and fig. 26, some of the same cells detached. They vary much in size; the secondary cells in the interior of the larger ones being similar to the smaller free cells. The mass of cells was much grown over with small colourless Spirilla, as shown in fig. 25; this was the case in very many, if not most, of the fronds.

Nostoc minimum (? n. sp.)—Frond ellipsoidal, very minute, about 1-120th inch, cells of the filaments somewhat square, but constricted in the middle on two sides, giving the filaments a crenate outline; vesicular cells globular and colourless. *Hab. In a pool (which dries up in hot weather) on Paul's Cray Common, Kent, June,* 1856.

Fig. 27 represents this species, which, as far as I know, is undescribed. I have named it for convenience of reference, although new species of Nostoc should be admitted with caution, the genus even being of doubtful validity.*

In conclusion, I have only to notice shortly the plants drawn in figs. 28 and 29. Fig. 28 I take to be a state of Chlamydococcus. The outer membrane was colourless, and the two internal globular cells of a clear bright ruby crimson. The peculiarity of the plant consisted in the fact of the cell being filled with minute staff-like subcylindrical bodies in active motion, precisely similar to the Spermatozoa of Vaucheria.† I watched these bodies at intervals for about twenty-four hours, and the motion was incessant. At the end of that time the cell slipped amongst some other Algæ on the same side and was lost. Whether these little active organisms were really Spermatozoa, or whether they belonged to the mysterious bodies which, in some way or another, are supposed to find their way from without into the cells of Algæ, it is impossible to say.‡

The other figure (fig. 29) represents, no doubt, the final stage of some Volvocine § in which the gonidia have become encysted.

I notice it because the encysted cells were of a pale yellowish-brown colour, and covered with minute pits or depressions, and were altogether different from those of any other Alga with which I am acquainted. In Pandorina and Stephanosphæra, the resting spores are red, in Volvox bright orange, and in neither case are there any such markings as those in the membranes of the cells shown in fig. 29.

* See Bayrhoffer, Entwickelung, &c.; von Thrombium Nostoc, Botanische Zeitung, 1857, p. 137; and Itzigsohn, 'Phykologische Studien,' Nova Acta, vol. xxiv, pp. 139—156.

† See 'Micros. Journ.,' Vol. IV, Pl. III.

‡ As to these bodies, see 'Bot. Ziet.,' 1857, No. 14, and Pringsheim's 'Jahrbücher,' Part ii, p. 371.

§ I have coined this substantive to avoid the periphrasis of "one of the Volvocineæ," or "a Volvocineous Alga."

BLACKHEATH PARK, S.E.,
June 1, 1858.

On the STRUCTURE *of the* RETINA. By THOMAS NUNNELEY, F.R.C.S.E., Lecturer on Surgery in Leeds School of Medicine, Surgeon to the Leeds General Eye and Ear Infirmary, &c.

THE retina is the sentient part of the eye, for which all the other textures are formed, and to which they may be said to be subservient. It is coextensive with the choroid proper; it covers the whole of the convex portion of the vitreous humour, and is covered by the choroid. It terminates in a serrated line, *ora serrata,* which is readily seen with an inch lens, just where the ciliary processes are continuous with the choroid. There is, according to some anatomists, a circular blood-vessel running near to this edge, if so, it is probably a vein, but it rather appears as a series of capillary loops of the central artery. Some of the older anatomists and opticians described the retina as being continuous over the anterior surface of the crystalline lens, an opinion which has been adopted to a great extent by Arnold, who describes and figures the retina as being continuous with the ciliary body and processes to the edge of the lens,*—*pars ciliaris retinæ* and *processus ciliaris retinæ.* This, however, is, without doubt, an error; though the retina does not terminate wholly and absolutely at the ora serrata, as is commonly described. The nervous structure here ends, but there is, continuous with the suspensory ligament of the lens, a cellular layer, as far as the edge of the lens: this is best seen after the eye has been kept for some time in spirit or Goadby's solution, by which the layer is rendered opaque and white. Its continuity with the retina may then be readily traced, and, indeed, in some eyes it looks so like a continuation of the whole retina as to render the microscope essential to prove that the nerve-structure is not so prolonged.† The retina has, until very recently, been described as the terminal expansion of the fibres of the optic nerve into a membrane. It is, however, much more than this; it is one of the most complex, perhaps the most complex, structure to be

* 'Icones organ. sen.,' tab. 3, fig. 2.

† In one instance of an alligator, I find a memorandum I made at the time of the dissection, to the effect that the retina was traceable to the edge of the lens; but as this was made before I was so well acquainted with the different structures in the retina, and the eye was not very fresh, I should not rely upon this apparent exception, but look carefully at these parts when opportunity again offers a similar creature.

found in the body, and instead of being thought of as simply a terminal nervous expansion, it should be regarded as in itself a nervous centre; having the fibres of the nerve expanded it is true in it, and by which it is connected with the brain, but possessed itself of structures and properties peculiar to it, and altogether different from those of the optic fibres, which are expanded in and make part of it. These fibres are for the purpose of conveying to the sensorium the impressions excited in the retina, but are not for receiving the impression, while the other complex structures of the retina receive and appreciate the impressions of external objects.

The inner surface of the retina is not merely superimposed upon the vitreous body, but is organically connected with it, by a series of clear, perfectly transparent cells; while the outer surface is most intimately united with the cells forming the inner layer of the choroid. It is an extremely delicate, thin structure, thickest at its junction with the optic nerve, and gradually becomes thinner as it reaches the ora serrata, where it is not more than a quarter the thickness it possesses at the back part of the eye.*

In the living condition the retina is as nearly transparent as possible, and of a slight pink tinge, but in a very short time after death it becomes translucent, then opaque: by immersion in water it very soon becomes so; and by spirit, heat, and all chemicals which coagulate albumen, it is immediately rendered quite opaque and white. In the fresh eye it is perfectly smooth, but, in consequence of evaporation from the eye, it is at the period when human eyes are commonly dissected found in irregular folds. The pink tinge of the fresh retina is due to the blood which it contains. It is a very vascular structure, deriving its supply of blood from the central artery of the retina, and, not improbably, some of its nutriment, though no vessels, from the choroid coat.

So numerous and complex, so minute and fragile, so transparent and changeable, so intimately connected and mingled together, so quickly altering after death, and yet, at least in man, so difficult to obtain immediately after death, so instantly and most importantly altering on the addition of almost every agent that may be employed in assisting in the examination of other tissues, that it is no wonder almost every description of these structures is different from others;

* Kölliker says, "Its thickness is at first 0·1 of a line, but as it extends anteriorly it soon diminishes to 0·06 of a line, until ultimately close to the anterior border of the retina it is not more than 0·04 of a line in thickness." ('Kölliker's Human Histology,' by Busk and Huxley, vol. ii, p. 369.)

and that one microscopist should find appearances which others have not. Hence, notwithstanding the careful labours of many of the most eminent anatomists and observers, it is very doubtful if we are yet in possession of the real living structure of all the parts in this wonderful tissue. Certain I am that many statements are incorrect, that *post-mortem* changes have been confounded with normal living forms, and alterations effected by reagents have been described as natural conditions. Thus, while it is easy to say that some of the descriptions are certainly not correct, it is by no means so easy to feel certain that one's own observations, however carefully and repeatedly made, are not also open to error. While, therefore, I have taken all the care I can, and spent much time upon the investigation, I would wish to be understood where differing from other anatomists in the description of these parts, as doing so with the greatest deference, and with the full recognition of the weight attached to their skill and experience in the use of the microscope, and as only stating that which I believe to be the forms during life of these minute structures, and not as asserting dogmatically what is incapable of dispute.*

The retina consists of several layers superimposed upon each other; commencing externally, these are—

* I believe the only way to examine the retina unchanged is to do so *immediately* after death, and without the addition of *any substance whatever.* So rapidly do the rods undergo change, that in a few hours they are completely altered; and not unfrequently even when taken from the living eye, they are seen to alter while under examination. I know of no fluid which does not more or less change them. Even chromic acid, which Kölliker so extols, is not without greatly modifying influence upon the true retinal elements; and water *immediately* materially alters, and soon quite destroys the rods, and alters the granules and bulbs. It is extremely difficult purposely to make a section sufficiently thin in the fresh retina to examine it in profile; and, if expanded and dried, it requires maceration to render it fit for examination, by which the structures swell and alter irregularly, whatever fluid be used, so that the natural forms are not obtained; but these examinations are important as helping the inquiry, and by employing different fluids the one error may to some extent correct the other. The fluid which I have found to preserve the retina in the most natural condition for the longest time, is Goadby's solution, No. 1, diluted by one half. My experience of chromic acid is much less favorable than I had been led to expect by the statement of Kölliker and others. It is true it renders the cerebral elements of the retina, the nerve-fibres, the nucleated cells, and the granules or granular cells, more distinct; but its action upon the rods and conoidal bodies is very considerable—if strong, there is one confused fibrous mass, coloured yellow by the acid; if much diluted, the rods break up into discs and granules, and the cones soon swell and disintegrate as with water. I doubt if its action be greatly superior to that of diluted acetic acid, which has the advantage of being colourless.

1. The columnar or bacillar layer, rods, Jacob's membrane.
2. Bulbous or conoidal bodies.
3. Granular layers.
4. Nucleated vesicular layer.
5. Vascular layer.
6. Fibrous layer.
7. Hyaloidal cellular layer.

1. The outermost layer of the retina is really a wonderous structure. It is quite peculiar to the retina, but is found in all animals where there is a retina, even in the eye-dot of the "blind mole." It consists of minute cylindrical bodies as innumerable as the sand upon the seashore. They are RODS or COLUMNS, arranged side by side, and stand perpendicularly to the centre of the eye; the outer ends are in close connexion with the choroid coat, the inner ends rest among the granules which form the third layer; they consequently stand at right angles to the fibrous expansion of the optic nerve. They may be traced uninterruptedly from the expansion of the optic nerve to the ora serrata; they are considerably the longest at the former situation, and appear gradually to decrease in length towards the fore part of the retina. They are so closely arranged as to constitute a complete coat. In man, mammalia generally, reptiles (except the chelonian,) and fish, they appear to be perfect cylinders, with clear, distinct, straight, transverse ends. In chelonians and birds, there are a few cylindrical, but they are for the most part bulbous or conoidal; the larger end being outmost. They have been sometimes described as six-sided prisms; undoubtedly not unfrequently they appear hexagonal—this, however, merely arises from their being compressed against each other, where not so they are perfectly round. In the frog and the toad by far the greater number are perfect cylinders, but I have seen some few amongst the mass with one end broader than the other. They are solid, perfectly transparent, highly refractive rods, quite straight in the living eye, but they very soon become variably distorted, as bent at right angles, particularly towards one extremity, the outer, or curled up at one end, like the hook of a walking-stick, as represented as the normal condition by Hassall; but of which not a trace is to be found in the eye of an animal just killed. They then curl up into oval or circular rings, so as to look very much like cells, and may easily be mistaken for blood-cells; occasionally they split longitudinally, but far more commonly they become marked by

transverse striæ and look like connected discs, then granular, and ultimately break up into transparent granules, and altogether disappear, so that in six, twelve, or twenty-four hours after death, hardly a straight, clear cylindrical rod is to be seen, and frequently in forty-eight hours or less not a trace of them is left.

They are very flexible, and may be seen to bend on encountering any obstacle—as when detached from each other they float about—and immediately this is passed, to again become straight; but I do not think they are elastic, that is, compressible. They are at the same time, very brittle, and most easily break. They appear neither to attract nor repel each other, but when brought into contact they often adhere by the parts which actually touch, so that if they happen to come end to end, two may easily be mistaken for a single long rod. They are largest in reptiles generally, and of these in the frog; next in fish, and smallest in man and mammalia. Though their size varies in different creatures, it bears very little proportion to the size of the animal or of the eyeball. Thus the rods of the frog, toad, and water-newt are as large or larger than those of the alligator; of the sparrow and canary bird as those of the fowl or turkey; of the duck as those of the swan; of the carp, trout, eel, and herring as those of the halibut, salmon, haddock, and cod. Those of the rat, mouse, and mole are nearly as large as those of the sheep, ox, and horse; of the monkey as those of man; indeed those of man, if anything, are smaller, and, I think, more numerous than in almost any other creature.

I have stated that I believe these in the living eye to be straight cylinders, but this is not the usual description. Hassall has described and figured them as curled into a knob at the outer extremity. This is a very common appearance when the eye has not been examined until the animal has been dead a short time, but certainly does not exist in the living eye; and may often enough be seen to form while the examination is going on; especially on the addition of dilute spirit, or after the unopened eye has been immersed in it for a short time. On the other hand, Hannover, in his beautiful plates ('Recherches microscopiques sur le Système nerveux') has described and figured all the rods as terminating outwardly in a conical extremity; this being in some animals prolonged into a long delicate filament, which is, he says, received into a minute sheath formed in the choroid coat, whereby the two tissues are organically connected together. In this he is followed to some extent by Mr. Bowman.

For this cone at the outer extremity of the rods, and its surmounting filament, I have searched most diligently, indeed I may almost say wishfully, as desiring to see what two such authorities have described as the true form, but I must confess to have failed. True, a short conical appearance is often to be seen at one or other extremity of the rod, but I have never been able to satisfy myself that it is not an optical effect, from the end not being in focus, for almost invariably I have found that by focusing the conical appearance disappears, when the rods are single, and while they are *in situ;* supposing them to be conical, and the cone enclosed in a sheath of the choroid, I do not see how it is to be observed, at least I have failed in the fresh eye, and so distorted do these small bodies become by drying the retina, and subsequently moistening it, or by the addition of any reagents, that I place very little reliance upon appearance then presented; nor do I think the statement of these observers, that the great disposition there is for the rod to break at the precise point where it becomes conical, is sufficient to account for the difficulty of finding the cone; for in this case the cones ought to be found separate in some abundance, considering the enormous multitude of rods; which they are not. Besides which, while they state that the *inner* end of the rod is perfectly straight, and the *outer* is conical and pointed, imbedded in the choroid, Hassall describes the outer ends of the rods as of a globular or oval shape, and Kölliker declares the opinion of the conical form of the *outer* end to be a mistake—that, in reality, it is perfectly flat and straight, while the *inner* end is not only conical, but sends a filament so prolonged as to pass entirely through the outer layers of the retina to the inner surface, where it terminates in radiating fibres as first described by H. Müller. Kölliker would appear to regard the rods as cells filled with fluid, for he says, that on breaking up, "they allow clear drops to exude, which are often met with on the external surface of the retina in vast quantity." This is contrary to the observations of most others, and does not correspond with what the rods appear to my eye, as above stated. By some the rods are described as cylinders, terminating in an expanded head like a nail; very often rods may be seen of this shape. I have seen this particularly in the rat; but it simply arises from the granule to which the inner end of the rod is attached still adhering to it; by watching for a while, it will be seen to become detached; often too they appear conical or swelled out, from a granule adhering to some other part of them.

In all birds, and in the turtle, the straight cylindrical rods

are comparatively few in number, the greater part of them are conoidal or fusiform in shape, the base being without, and they are surmounted by a highly transparent coloured globule, which is closely attached to and partly imbedded in the end of the rod. The number of the true cylindrical rods in aquatic birds, as the duck, goose, or swan, appears to be very much less than in land-birds; indeed, in some it is questionable if all the rods are not more or less conoidal in shape, but they are so to a less extent than are those of land-birds. The globules are evidently cells filled with a coloured fluid, which reflects light almost like oil, but is not oil; for the cells are not soluble in either spirit of wine, or dilute potash, ammonia, acetic or chromic acids; and when the globules are crushed, and the coloured fluid has run together and dried, it is soluble in water, while the dried globule, by immersion in water, swells out to even a greater than its normal size. They are unaffected by immersion in boiling water; they are well seen by the addition of chromic acid; and then, if liq. potassæ be added, the colour is destroyed, but their shape and size are well shown; the rods are dissolved, and thus they are left free. Many of the globules are of a beautiful ruby red; others, and the greater number, three or four to one, of a canary yellow, some approaching to a green tinge; some few I have seen of a decided green colour, and in some the colour is so pale, as to be hardly perceptible. Though the yellow are the most numerous, the ruby are for the most part the largest. There is no fixed relation either in number or size, nor are those of the same colour always of the same size, varying in the bird from $\frac{1}{6000}$ to $\frac{1}{12000}$ of an inch; and I think the size, number, and relative proportion of the two colours differ in different parts of the same retina. In a guinea fowl, I found the globules very nearly uniform in size, about the $\frac{1}{5500}$ of an inch, and the globules of pretty nearly the same tints of ruby and canary colours. I have found there is more variation in size and colour of the globules in young fowls than in old. Though closely imbedded in the rods, they easily become detached and float about; they are also attached to the choroid coat, but not so intimately as to the retina, for in separating it from the retina they always adhere to the latter. They are much more persistent than most of the other elements of the retina, and may be preserved, when dry, for some time. Hannover, who was the first to describe these bodies, has figured the ruby as attached to what he calls *cones jumeaux*, and each of these as surrounded by six rods, surmounted each by a yellow globule, forming a setting for the ruby. I

do not think any such precise relation in number or position exists.

I know of no more beautiful object under the microscope than the outer surface of the retina of a Cochin cock, guinea fowl, or turkey, and particularly of a turtle. Could a lady deck herself in jewels so brilliant and beautiful, she would esteem herself the gayest in a ball-room. I know of nothing except the corneal facets of a coleoptera to compare with it. In some birds the colours are much more intense than in others. I thought it possible the colour of the feathers might have some connexion with this, but it does not appear to have; for instance, the yellow globules of the canary bird are not more numerous or intense than those in the sparrow; the ruby in the brilliant game cock than in the gray guinea fowl: nor does there appear to be any difference in two similar birds of different plumages, as in a white and a variegated fowl. However, I do not think, in aquatic birds, they are so brilliant in tint as in land-birds, nor is there altogether so much difference in the size of the two-coloured globules. But, of all creatures which I have examined, the coloured globules are the largest and most distinct in the green turtle. The ruby are, as in birds as a whole, larger than the yellow, and are more uniform in colour; whereas the tint of the yellow, like their size, varies very much, from a full canary, to nearly or completely colourless white.

Similar, but not nearly so perfect globules, are found in some other reptiles. I have seen them in the toad and the frog; in the latter of which they are most distinct; and in some fish, the eel for instance, globules of the same general size and appearance, but of a brown colour, more like those of the choroid, but larger, are to be found. So in some mammalia brown globules of the same size and general characters are to be sometimes sparingly met with. In viewing these coloured cells they often appear as containing a circular nucleus, which is, however, only an optical effect, for by adjusting the focus it always disappears. Hannover describes this appearance as resulting from the cells being conoidal, and both ends being seen at the same time. In some few cases I have thought the detached cells conoidal, but this is so very rare compared with the frequency in which no doubt can exist of the generally perfectly globular character of both ruby and yellow cells, that I rather incline to attribute it to the end of the rod in which the cell is partially imbedded being seen, than to the cause mentioned by Hannover. In one bird, the common fowl I believe, the globules had a short projecting spur, which was received into

the end of the rod, and which might give rise to the appearance; and in the turtle I have seen a few of the globules with a similar minute projection on one side, as though it had been imbedded in the conical rod; in the swan, where the globules are not particularly well developed, I have found some few fusiform in shape.

The use of these globules I can offer no conjecture upon.

Internally the rods pass in amongst the granules, and the end of each rod appears to rest upon and be connected with one or more granules. Externally the end of the rod is, I think, implanted upon the cellular or epithelial, as it has properly been called, layer of the choroid; the clear portion, which has been regarded as the choroidal cell, being that where the rods have adhered; for there can, I think, be no doubt that the retina and choroid are organically connected together, the rods probably deriving their nutriment from the choroidal vessels; no blood-vessels are to be found in the columnar layer itself.

The rods are evidently a nervous structure, *sui generis*, their whole appearance indicates this, and probably they are intimately connected with the sense of vision; but in what way they act, whether as independently perceiving the image, which the nervous fibres only place in relation with the sensorium, which then intelligibly appreciates the information, or only as affording a suitable surface for the imprinting the image upon, which the nerve-fibres then convey to the sensorium to be there perceived, it is premature to discuss; but their complex character would rather point to their possessing some independent function, than to their being the mere recipient surface for an image, to be thence conveyed to the brain as the sole sentient part. Whether they are the real terminal expanse of the optic fibres, as Kölliker seems to suppose that Müller's and his own observations indicate, is, to say the least, unproved; nor does it appear to be necessary for our estimate of the importance of their functions. That they are in connexion direct or indirect is more than probable, but that they are to be regarded as the expanded nerve-ends does not seem so probable as their being peculiar nervous structures, having separate and individual power. Where there is the greatest amount of intelligence they appear to be the smallest and most numerous.

This is the structure which was first pointed out as a distinct layer of the retina by Dr. Jacob, and has since been known as the membrane of Jacob; though its nature was not, indeed could not have been, known by him. He

regarded it as a protecting membrane, interposed between the nervous retina and the choroid. This notion became commonly adopted, and was much extended by other anatomists, some of whom, particularly the late Mr. Dalrymple, argued very strenuously for its being a true serous membrane, constituting a shut sac like the pleura or arachnoid, a view he supported by arguments, drawn from analogy and pathological conditions, which he thought satisfactory. Of course, now that its structure is so far known, this idea must be altogether dismissed. It is most easily detached in translucent shreds from the other elements of the retina as soon as decomposition begins, or on immersion in water. When this occurs it is evident that the structure has undergone a change; the rods are then altered. (Plate X, fig. 3.)

2. The *cones* or *bulbs* constitute the second layer of the retina; however, as these bodies when found are always placed amongst the rods towards their inner end, they are hardly to be considered as forming a distinct layer, though for convenience of description it is necessary to speak of them separately. Regarding them there is even more difficulty and uncertainty than with the rods. As to the latter no one can doubt their existence in the whole of the vertebrate division, whatever differences of opinion may be entertained as to their form and connexion, but the very existence of the bulbs, in by far the greater number of animals, is open to considerable doubt; and of their form, number, and connexion, to much more. Hannover, who has given the most elaborate description and figures of them, from their form, denominates them *cones jumeaux*, *coni gemini*—twin cones, and says they consist in the fish, where they are most developed, of double cylindrical bodies, two or three times as large as the rods, placed side by side: that each of these cylinders is divided into two equal parts; an internal one, smooth and round, as though enclosed in a delicate capsule, separated from the external half by two transverse lines; and an external moiety, composed of a mass of minute granules, and terminating outwardly in two conical points. That after a time, or on the addition of a liquid, the inner cylindrical portion becomes larger and fusiform, bilobate like a coffee-berry and granular, while the conical points fall off, curve themselves into hooks, and often altogether disappear. That the *cones jumeaux*, like the rods, are planted perpendicularly to the other elements of the retina and choroid, that each *cone jumeau* is completely surrounded by a regular number of the rods, and that each of the two conical points is, like the filaments of the rods, received into a membranous

sheath of the choroid, as the corolla of a tubular-shaped flower is surrounded by its calyx, but that the sheath without colour in reality encloses the entire cone. That the cones are wanting in all reptiles except the chelonian.

In birds Hannover considers bodies very different in form as the *cones jumeaux* (those which I have called conoidal or fusiform rods); because they are sometimes surmounted by two coloured globules and are surrounded by the rods. He states, as already mentioned, that the citrine-coloured globules are situated at the outer end of these cones.* In mammalia he describes the *cones jumeaux* as being shorter than the rods, with their external ends terminating in two short and abrupt points.

Mr. Bowman was the first to describe the bulbs in the human retina. He says they are solitary, globular, or egg-shaped, transparent bodies, sometimes having a small blunt spur upon them, turned towards the choroid, placed at regular intervals amongst the rods, much less numerous than the rods, of larger size, but not so long, and sessile upon the granules. Unlike Hannover, who believes these bodies not to exist in reptiles except the chelonian, Mr. Bowman thinks they not only do exist, but that in the frog they are nearly as numerous as the rods.

Hassall, in his description of the microscopic anatomy of the eye, makes no allusion to the existence of such bodies as cones or bulbs, which evidently he had not detected.

Kölliker's figures and descriptions of the cones are altogether at variance with those of both Hannover and Bowman. He states that the cones are rods, which instead of a filament at their inner extremity, are furnished with a conical or pyriform body. That each cone consists of an *external*, thicker and longer finely granular extremity, more or less ventricose, and which passes into a common rod; and an *inner*, shorter portion, in which an elongated or pyriform, more opaque and brilliant body, is enclosed; the cones being, like the rods, continued by fine filaments into the deeper layers of the retina.

I have searched most carefully for these bodies in the eyes of many animals, but I cannot say that I have satisfied myself of the existence of any bodies such as have been described in the perfectly fresh eyes of any creature, except

* In the text Hannover states that the *cones jumeaux* are surmounted by the citrine-coloured globules, while in his figures of these parts, and in the description of them, he represents the cones as surmounted by the ruby-coloured globules. ('Recherchés microscopiques sur le Système nerveux.')

fish, and even here, they do not, so far as I can ascertain, exactly correspond with the description given by Hannover; and in the turtle, where the bulb is distinct. In sections of retina from the higher animals, which have been dried and moistened by various reagents, or even fresh retina treated with dilute chromic or acetic acids, it is not difficult to find various-shaped particles, which may be supposed to be these bodies, but inasmuch as they are not to be detected, so far as I can ascertain, in the perfectly fresh eye where its retina alone is examined, I am doubtful of their actual existence as distinct bodies. There is no difficulty whatever, when regarding the undisturbed external surface of the retina of either reptiles or mammalia, of recognising the forms figured by Hannover and Bowman, which they consider the cones or bulbs not in focus, but I have always failed in detecting the appearances represented by them in profile, and I am more inclined to think the bodies seen at a deeper level, and out of focus, when the outer ends of the rods are in focus, not as cones or bulbs, but as the outer portions of the granular layer to be presently described, and upon which the ends of the rods rest, indeed are closely attached to; or as the inner ends of the rods themselves, not in focus.

That coffee-shaped granular bodies, often more or less bilobated, are to be seen in the retina of many animals is certain, but I have so commonly seen rods to assume this form while under the microscope, that I strongly suspect many of the forms which have been described as cones are really only modified rods. That bodies at all resembling the *cones jumeaux* of fish, which may be regarded as the type of these cones, exist in mammalia or most reptiles, I am persuaded is incorrect. I have examined the eyes of the alligator, the chameleon, the newt, the frog, and toad, the last three over and over again, both young and old, fresh and dried eyes, without being able to detect any. Moreover, Hannover's own account of what he calls these bodies in birds shows them to be altogether different structures from what he describes under the same name in fish. In birds there are, as has already been stated, numerous conoidal bodies surmounted by a brilliant coloured globule, but they appear to differ very little from rods, and their broader end is external, while they are in no respect double, nor have they any sharp conical points, either single or double.*

* To describe bodies which differ so essentially as the *cones jumeaux* of fish, and the elongated bodies which are surmounted by a coloured globule in birds, as the same structures, appears rather as a predetermination to find an uniformity of structures, than a simple representation of what

In fish there certainly exist imbedded between the deeper ends of the rods, and like them, resting upon the granular layer, a number of conoidal bodies of larger diameter than the rods; each consists of two portions; an oval bulbous part when two are pressed together, globular when they are single; and a conical one of about equal length. The point of junction is marked by a very fine transverse line, and where, commonly, but not invariably, a separation takes place. They reflect the light strongly, and are at first perfectly transparent, solid, and homogeneous. The conical end breaks up into discs, and then granules, exactly like the rods, while the bulb swells and becomes less transparent, then granular, often irregular in shape, not unfrequently it splits more or less completely into two portions, and then disappears in granules. When the conical leg has become detached and the bulb somewhat split, it resembles much a coffee-berry. These changes occur within a very short time after death. I have seen them take place while the part was under examination, within fifteen minutes after the fish had been swimming in the water. They occur immediately on the addition of water, and many other reagents. These cones lie with the bulbous end resting upon, and connected with, one or more granules, the narrow end always being outwards. They are closely connected with the rods. There does not appear to me to be any such regular relation in number and arrangement between them and the rods as is described by Hannover; they often are solitary, but very commonly two are side by side, when they may closely adhere by their sides, which are flattened as by pressure, and which has probably given rise to the idea of their being double, but they may be separated without any division of structure in the greater number of fish, though perhaps not in all. The cones are, I believe, commonly single, and I do not think they are enclosed by any sheath from the choroid; indeed, in some fish they do not appear to reach the outer surface of the retina, being shorter than the rods, as in the golden carp; while in others they are quite as long or even longer, as in the cod and whiting. The relative proportion of them and the rods appears to differ in different fish. In the sand-dab, *Platessa limanda,* and the Ballen-wrasse, *Labius maculatus* the cones are comparatively few; while in the whiting, *Merlangus vulgaris,* and the little weaver, or venom fish, *Trachinus vipera,* they are much more numerous; in the mackerel, *Scomber scomber,* they are very

really is seen—an attempt to generalise than a record of what actually exists—the small ovoid bodies more resemble the *cones jumeaux* of fish than do the conoidal rods.

large. In some portions of the same retina they also appear more plentiful than in others, and in some fish, as the golden carp, *Cyprinus auratus,* the venom fish, and the cod, they appear more distinctly as single bulbous bodies, often two lying close together, having each a single conical projecting part; while in others, as the whiting, the bulb more commonly appears as single at first, with two conical projecting parts, and subsequently to split into two portions. The conical portion very closely resembles in character the rods, while the bulbous part more nearly approaches the granules. Can they be regarded as rods in the process of development? By water they are immediately broken up; by ether much distorted, and then destroyed; by ammonia they are instantly (as are the rods) dissolved; by acetic acid they are also destroyed, and only a clear globule left. Chromic acid also acts upon them, if strong it distorts them much, if dilute it acts as water; acetic acid has a similar action.

The retina of the turtle, if examined instantly the animal is killed (for like all others it changes in few hours), is a very interesting sight. The outer surface is composed of conoidal rods, in shape very like those of a bird, and like them surmounted by brilliantly coloured globules, partially imbedded in the rods. These rods are of large size with the narrow portion inwards, and between them lie a number of oval bodies, which are clearly the bulbs of Bowman. They do not reach the outer surface of the retina; they are clear, transparent bodies, exactly in texture like the conoidal rods, and like them, after the lapse of a short time, or immediately on the addition of almost any substance, becoming granular. There are also to be seen a great number of ovoid bodies of nearly the same size as the bulbs, surmounted by coloured globules like the conical rods; whether these are bulbs with coloured globules attached, or whether they are altered rods, with the inner narrow part detached, I am not able to satisfy myself, but I incline to the latter opinion, for they cannot be seen *in situ;* and certainly in many instances, the conoidal rod appears with the outer part swelled out into a granular bulb, while the inner part is detached and breaks up into small discs and granules before disappearing, but, on the other hand, the end of many of the bulbs as they float about appears perfect. They carry ruby and canary coloured globules of various sizes indifferently. I have never seen two globules attached to either one rod or one bulb (as Hannover says occurs), but I have often seen a loose coloured globule accidentally become attached, or the globules of two neighbouring bodies so lying as to require great care to distinguish

as belonging to two different bodies. There are a few cylindrical rods, some of these are long and narrow, and appear to lie intermingled with the conoidal rods, while there are more which are shorter and thicker, and appear to be the inner ends of the altered conoidal rods broken off, and would thus resemble the conical portion of the *cones jumeaux* of fish—except that in fish the ends certainly are external, while in the turtle these portions as certainly lie internally; and in fish the bulb breaks longitudinally into a coffee-berry shape, in the turtle it does not. There are few of the larger granular cells in the turtle as in. fish; but the inner finely granular layer of cells is seen, as are the nerve fibres. (See Pl. X, where these bodies in the natural and altered condition are shown.)

3. The *granular*, as it is called, forms the third layer of the retina. The name is not a very correct one, for these bodies are certainly not granules, as they have been described, but are cells filled with highly refractive, solid, granular nuclei. The walls are so thin and easily ruptured, that, after a time, or when reagents are applied, or insufficient power is employed, only granular matter is to be found; but when a perfectly fresh eye is examined with an eighth glass, or still better a twelfth and an achromatic condenser (see Pl. X,) not the least doubt can be felt as to their being cells filled with granules. They are usually irregular in outline, probably from compression against each other. They are found in all animals who possess a retina, but very far less in number in fish and reptiles than in man and mammalia, where they exist in enormous multitudes. They appear of pretty much the same size and character in most animals as seen on the slide by transmitted light. They are of a pale yellow colour, and refract the light strongly like oil, their size varies considerably, some measuring $\frac{1}{5500}$, while many are not nearly half this size, some not more than $\frac{1}{20000}$ of an inch. They bear a strong resemblance to, and are probably identical with, the cells found in the cineritious matter of the cerebral convolutions. They lie between the rods, which rest upon their outer surface, and the fibres of the optic nerve, and constitute in mammalia a considerable portion of the thickness of the retina, though not so much as the rods do.

Bowman and Kölliker, both describe the granules as consisting of two layers, separated from each other by an indistinct fibrous layer, the outer of the layers being the thickest; but they are opposed to each other as to the size and shape of the globules forming them. Thus Bowman describes the granules forming the inner layer as smaller than the outer,

of a flattened form, like pieces of money (hence named by him nummular layer), with the flat surfaces corresponding with the thickness of the retina; while Kölliker says the inner are larger than the granules of the outer layer, and arranged with their long axes in the direction of the thickness of the retina. If a section of the dried retina of man, the sheep, or the ox, be examined with water or dilute spirit, there is no difficulty in perceiving this irregular line of very minute granular matter and indistinct fibres with flattened globules arranged horizontally in the length of the retina, as described by Bowman, and not vertically in the direction of the thickness, as figured by Kölliker; but it is by no means so easy to detect this separation into two layers in the perfectly fresh retina. I have sometimes fancied it was to be seen in the bullock and sheep, but I have so often not been able to find it, that, knowing how greatly every portion of the retina is changed by all fluids, and how little dependence is to be placed in appearances there found, I feel doubtful if there really be two layers. The globules placed most internally are smaller than the external. It is, I think, in the innermost part of this and the next layer that the capillaries of the blood-vessels are principally situated, though Bowman says, they have no blood-vessels, and certainly none appear to be distributed in the mass or thickness of the layer. On the addition of water and many other fluids, the globules separate from each other, float about, dilate, rupture, and disappear, leaving only fine granules, which also dissolve. They are rendered more distinct and refractive by dilute acetic and chromic acids, in which they are well seen.

The rods rest upon and are imbedded amongst them, each rod being intimately connected with one globule, which often remains attached to the end of the rod when the rods are detached from each other. This has given rise to the impression of the rod having a head like a nail, but in a few minutes it usually becomes detached, and is then seen to resemble the other globules. It may be doubted how far the connexion is organic or not, as the same globule may be seen, if it happen to come in contact with another rod, to adhere to any part of its surface.

4. On the inner surface of the granular or nuclear layer is the *vesicular layer*—"gray vesicular matter of retina"—"cineritious cerebral substance," which is a very thin layer, composed of finely granular or cellular matter, of apparently the same nature as the last, and probably more correctly to be regarded as its commencing portion than as a distinct structure, in which also are numerous larger and clear trans-

parent cells with large eccentric nuclei and nucleoli, identical with those found in the cerebral convolutions. It is very difficult to see these brain-cells *in situ* in the fresh eye, but floating about they are readily seen; and in a successful examination they may be seen forming a layer in which the fibres of the optic nerve are imbedded and expanded. Plate X.

In this layer, Bowman, Kölliker, and Hassall all describe, as being found, besides the circular brain-cells, caudate ganglionic cells. Hassell says only to be found in man; Bowman in man and the horse, amongst mammalia, but particularly well developed in the turtle; while Kölliker figures those from the ox with very long processes, and his description would inferentially lead to the supposition of their being generally distributed. Bowman says they do not contain any pigment, while Hassall represents them as altogether dark, and Kölliker as containing pigment in the body of the cells, with the large central nucleus transparent. Hannover, in his elaborate account of the retina, makes no allusion to any such cells, yet he was perfectly familiar with the character of caudate nerve-cells, for he has figured them as seen in different parts of the brain and spinal marrow, and therefore we may conclude he either had not found them or does not believe in their existence.

I have searched most carefully, over and over again, for these long caudate cells in the eyes of man, many mammalia, various birds, reptiles, and fish, and particularly in the almost living eye of the turtle, and must confess, like Hannover, have failed to find them in the perfectly recent eyes. When reagents are employed, when the retina has been dried and moistened with water, or the retina examined is not from an animal just dead, not the same difficulty exists; large, irregular, more or less caudiform cells are then abundant enough. I am therefore, unwilling as I am not to see what such competent observers speak unhesitatingly of, constrained to doubt if cells such as figured and described, with many long caudate processes, continuous with the nerve-fibres, do really exist in the living eye.

There are, however, constantly found, particularly in the eyes of mammalia, cells of various sizes; some large, very much resembling in form, only perfectly transparent, epithelial cells. They are flat, irregular, contain nuclei and fine granules, lie singly or in groups overlapping each other, and are in connexion with, if not imbedded in, as I believe, the granular layer, which they so much resemble, that unless caught detached from it, at first, until the eye is familiar with their indistinct outline, they are very difficult to recognise. I give figures of these cells from the retina of the human fœtus, the

pig, the ox, and the sheep, all just dead. (Pl. X, fig. 7.) They are, probably, in composition, similar to the granular cells, and like them break up and disappear. There is, certainly, no pigment matter in them; and whether they are the cells described by Bowman, Kölliker, and Hassall as the caudate ganglionic, I am uncertain, but believe them to be. In which case, either I am wrong in being unable to see the prolongations, or the cells described by them are modifications produced by the reagent employed, which I am inclined to suspect to be the case, seeing that I have often found the angles much prolonged when reagents, particularly chromic acid, have been employed.

5. *The fibrous layer* is composed of the filaments of the optic nerve. This nerve, which consists of nerve-tubes and cerebral cells, enters the ball of the eye through the cribriform plate of the sclerotic coat, with which the fibrous sheath of the nerve-fibres becomes confounded, and then through a narrow single aperture in the choroid coat, which is closely, but not organically, connected to the nerve. This entrance varies in its relative situation in different animals; in man, being to the inner side, and below the axis of the ball. The nerve here forms a slight mammillary projection, in the middle of which the central artery of the retina is seen. From this spot the nerve-fibres expand in every direction, forming a complete layer upon the outer surface of the hyaloid membrane.

The fibres pass as far forwards as the ora serrata, but as yet the exact mode in which they terminate is unknown; some observers have asserted that they form loops and return upon themselves, others that they are lost in the other elements; but I believe no one has demonstrated their termination. My own impression is, that these fibres are of different lengths, and successively terminate as they pass forwards, by being lost or continuated into the true retinal elements, the granules being the connecting medium between the nerve-fibres and the rods: and that the number of the fibres at the anterior part of the retina is much less than at the posterior, not merely because in forming a continuous expansion over a larger area necessarily there must be fewer fibres in any given space than there is in the smaller, but because the fibres are continually terminating, so that they are really fewer in number in the anterior than in the posterior part of the retina. *

The fibres lie to the inner side of the granular layer, which

* Instead of speaking of the fibres as terminating in any of the retinal elements, it would doubtless be more correct to speak of them as arising from or being continuous with them, the optic being an afferent nerve.

separates them from the rods, and they are, as it were, imbedded in the vesicular layer, which, without care, always renders the fibres indistinct. These may be seen in man, animals, birds, reptiles, and fish, on both sides of the fibres. (See Pls. X and XI.)

Much discrepancy of opinion prevails as to the exact nature of these fibres. Hassall and Bowman assert that they are flattened solid fibres of gray matter, not tubular, the white nerve-matter ceasing as the nerve passes through the sclerotic coat, or almost immediately after it has entered the eye, and that in passing forwards they anastomose, so as to form elongated meshes, in which nucleated vesicles appear. Hannover states that the fibres in the retina appear to possess greater consistency than they do in the trunk of the nerve itself, but otherwise have the same character. That they proceed forwards in straight lines, without subdividing or anastomosing, and never become varicose. (The latter statement he modifies in a note, and allows that they do, when not in a natural state, become varicose.) Kölliker says, each fibre enters the eye without its sheath of connective tissue, independent of the others; that, radiating in all directions, they constitute a continuous membrane as far forwards as the ora serrata, running parallel to each other, or inosculating at very acute angles, are without nuclei, and form frequent varicosities. He styles them the horizontal fibre system, in contradistinction to the rods and cones, which he calls the radiating fibre system. My own observations agree more nearly with those of Hannover and Kölliker, than with Hassall and Bowman, though not exactly with either. If the formation of varicosities is to be regarded as showing the tubular character of nerve fibres, I can entertain no doubt that those of the retina are as much tubes as those in the optic nerve, with which I believe they are directly continuous, and also possess the same characters. I have seen the fibres in the retina in man, sheep, oxen, birds, reptiles, and fish become varicose while under examination; the addition of a little water, dilute acetic acid, or mere variation in the pressure, will make them so at once, and often after being in weak spirit for a short time they are found so, particularly when the cerebral cells are gently removed before examination. When a particle of the optic nerve, and another of the retina, of perfectly fresh eyes of almost any mammal or fish, are examined with the assistance of either very dilute ammonia or chromic acid, it would be very difficult to point out the difference in the fibres of the two; their size is the same; and with those from the retina, perfectly clear cells with double walls, different from the nu-

cleated cerebral cells forming the fourth layer of the retina, but perfectly like those in the optic nerve, may be found. In the retina the fibres are somewhat wavy as they pass forwards, they reflect the light strongly, and at times, though, I think, not very frequently, they form anastomoses with each other; or at any rate appear to do so, at long intervals, and at acute angles; and my impression is, they terminate in the granular layer, though this is by no means demonstrated.

In the fish these fibres are larger than in mammalia, not so distinctly tubular, run straighter, are not seen to inosculate, and do not, so far as I have observed, so readily become varicose, though they sometimes do, as in in the cod (Pl. XI, fig. 10), altogether presenting more the character of gray fibres, without the white tissue, than in higher animals. The optic nerve projects further into the eye of fish than it does in them. As the retinal fibres appear to me to be identical in structure with the nerve-fibres, so I believe them to be in function, and to merely convey the impressions to the sensorium which the true retinal elements perceive. This would satisfactorily explain why the part of the eyeball where the nerve enters it, and where only nerve-fibres exist, must necessarily be insensible to visual impressions.

6. *Hyaloidal cells.*—On the inner surface of the fibrous layer, interposed between it and the vitreous humour, is a layer of perfectly clear, transparent cells, having very thin walls, free from nuclei, but which after a time become very delicately granular. Hassell describes them as situated on the outer surface of the fibrous layer, and thus in the texture of the retina, which is certainly wrong, while Bowman considers them as part of the hyaloid membrane. Whether they should be regarded as part of this or of the retina is doubtful, though, as they appear to be more intimately connected with it than with the hyaloid membrane, I incline to think them a part of it. They appear to be the medium of connexion between the two, and serve to organically unite them. When detached they are perfectly globular, but when *in situ*, and particularly when somewhat enlarged by imbibition, as they become if the eye be immersed in fluid for awhile, or by the action of its own fluids, they are irregular in outline and overlap each other from distension. They appear to form a single layer of cells. Their size varies much in different animals, the size of the creature being no guide to the size of the cells. They, however, appear to bear some relation to the size of the rods and blood-discs, as these do to each other. They are larger in birds than in mammalia, the largest I ever saw being in the turkey and in a canary bird, (Pls. X and XI), though these are probably enlarged by endosmose.

The retina is much more easily separated from the vitreous humour after a time than it is immediately after the death of the animal, which may arise from the change these cells undergo.

7. *Vascular layer.*—The retina is a very vascular structure; it is supplied by the central artery of the retina, which almost as soon as it enters the eye divides into two or three branches, which immediately subdivide and form a series of inosculations; the branches pass forwards and form a complete vascular network, until the vessels become capillary, which they do suddenly from vessels of comparatively large size. At first the larger branches are on the inner side of the fibrous layer, but as they pass forwards they gradually penetrate this, some of the branches running parallel with the nerve fibres for a considerable distance, (Pl. X, fig. 4); but the smaller branches and capillaries, which form beautiful loops with each other, appear to be exclusively distributed in the vesicular and granular layers, on the outer surface of the fibrous, (Pl. XI, fig. 7); none, so far as can be detected, passing into the bacillar layer. Many of them form terminal loops at some distance from the anterior termination of the retina, (Pl. XI, fig. 8). Near the ora serrata there is described to be a circular vessel, into which many others pass; this is regarded by some anatomists as a vein.

It is necessary in injecting these vessels to do so from the ophthalmic or carotid arteries; but the larger branches are so commonly found congested after death, that they may be readily seen, and not unfrequently the smaller ones are so filled with blood, that their minute ramifications may be examined with great facility, particularly where cerebral congestion has existed during life, or immediately after death the animal has been placed with the head in a depending position. (Pl. XI, fig. 7), is taken from the retina of a woman who died of cerebral congestion. In the other eye a small apoplectic clot was found, and several patches of convoluted highly congested vessels.

This communication has already occupied so much space, that I must reserve until another opportunity a description of the punctum centrale of Soëmmerring. I append the size of the rods and granular cells in some mammalia, and of the rods, cones, and bulbs in some birds, reptiles, and fish, in parts of an English inch. I would, however, wish the measurement to be regarded as no more than an approximation to the absolute size of these bodies, which certainly differs in different parts of the same retina.

MAMMALIA.

	RODS. Long.	RODS. Wide.	GRANULAR CELLS.
Man	1-2700 to 1-1800	1-10,000 to 1-6,500	1-16,000 to 1-5000
Ditto, at yellow spot	1-1800	1-6,500	
Pig, No. 1	1-2700 to 1-1800	1-10,000 to 1-7,200	1-16,000 to 1-5000
Ditto, No. 2	1-2000 to 1-1500	1-10,000 to 1-7,000	1-16,000 to 1-5000
Dog	1-2500 to 1-1375	1-12,000 to 1-6,000	1-16,000 to 1-5000
(Small spaniel)	most about 1-1800	most about 1-7,000	
Cat	1-2700 to 1-1800	1-16,000 to 1-10,750	1-16,000 to 1-6000
Horse	1-1800 to 1-1250	1-10,800 to 1-6,000	1-16,000 to 1-4000
Bullock	1-2000 to 1-1400	1-10,000 to 1-5,500	1-16,000 to 1-4000
Sheep	1-2500 to 1-1550	1-10,000 to 1-7,000	1-16,000 to 1-5000
Rat	1-2700 to 1-1800	1-14,000 to 1-10,000	1-12,500 to 1-5500
Mouse (both the common house and short-tailed field)	1-2700 to 1-1800	1-10,800	1-16,000 to 1-6500
Hare	1-2700 to 1-1800	1-10,800	1-16,000 to 1-6000
Rabbit	1-2700 to 1-1800	1-10,800	1-16,000 to 1-5500
Hedgehog	1-2700 to 1-1800	1-10,800	1-16,000 to 1-6000
Mole	1-3000	1-12,000	1-20,000 to 1-8000

BIRDS.

	Rods.		Coloured Globules.		
	Long.	Wide	Ruby.	Yellow.	
Turkey—					
Cylindrical rods	1-770 to 1-650	1-11,000 to 1-7000	1-7000 to 1-4000	1-16,000 to 1-5000	Yellow globules are three times as numerous as the ruby; some few are as large, but on the whole they are considerably less, some being very small.
Conoidal rods	1-770 to 1-650	1-4,000 to 1-2000			
Common Fowl—					
Cylindrical rods	1-770 to 1-650	1-11,000 to 1-7000	1-7000 to 1-4000	1-16,000 to 1-5000	As above.
Conoidal rods	1-770 to 1-650	1-4,000 to 1-2000			
Guinea Fowl—					
Cylindrical rods	1-750 to 1-650	1-11,000 to 1-7000	Ditto	Ditto	
Conoidal rods	1-750 to 1-650	1-4,000 to 1-2000			
Sparrow and Canary Bird	Ditto	Ditto	Ditto	Ditto	
Domestic Duck—					
Most of rods conoidal	1-770 to 1-675	1-5,400 to 1-4000	Ditto	Ditto	
Domestic Goose—					
Some conoidal, but more cylindrical, rods	1-1100 to 1-775	1-5,500	Ditto	Ditto	
Domestic Swan—					
Most conoidal rods	1-850 to 1-750	1-6,000 to 1-4000	Ditto	Ditto	
Ovoid bodies	1-1800	1-2,700			

REPTILES.

	Rods.		Coloured Globules.	
	Long.	Wide.	Ruby.	Yellow.
Turtle (green)— . .				
Long cylindrical rods .	1-900 to 1-675	1-11,000	1-5500 to 1-3000	1-10,000 to 1-5000
Short cylindrical rods .	1-1365 to 1-1100	1-5500		
Conoidal rods . .	1-700 to 1-600	1-2700		
Globular or ovoid bodies, bulbs or cones . .	1-1800 to 1-1350	1-4000 to 1-2000	Some, however, of both ruby and yellow globules are so small as to be hardly perceptible; with 1-8 object glass, not more than 1-200,000.	
Common Frog— . .	1-600 to 1-360	1-5000 to 1-2500		
Majority of rods, about	1-500			
Toad	1-900 to 1-700	1-4000 to 1-3000		
Alligator	1-900 to 1-600	1-5500 to 1-4000		
Very few rods so long as	1-600			
Chamelion	1-1365 to 1-1050	1-5500		

FISH.

	Rods.		Bulbous or Conoidal Bodies.		
	Long.	Wide.	Long.	Wide.	
Cod	1-1050	1-4700	1-1050	1-2500 to 1-1700	
Haddock	1-1050	1-4700	1-1050	1-2500 to 1-1700	*Conical legs and bulb of equal length.
Whiting	1-1500 to 1-1100	1-11,000	1-1000 to 1-800*	1-1800	
Billett	. . . . .	. . . . .	1-900 to 1-700	1-2500 to 1-1700	† Of which the conical legs form rather more than one half.
Sand Dabb	1-1800 to 1-1360	1-16,000 to 1-11,000	1-1800 to 1-1360†	1-2700	
Little Viper fish	1-1040 to 1-900	1-16,000 to 1-11,000	1-1040 to 1-900	1-4000 to 1-2000	
Mackerel	. . . . .	. . . . .	1-900	1-1360	
Carp (golden)	1-1360 to 1-1080	1-11,000 to 1-5500	1-1800 to 1-1050	1-2700 to 1-1800	
Greyling	1-1000 to 1-900	1-16,000	1-900	1-2700 to 1-1850	
Trout	1-1000	1-16,000	1-900	1-2700 to 1-1800	
Dace	1-1000	1-16,000	1-900	1-2700 to 1-1800	
Perch	1-1100 to 1-620	1-11,000 to 1-5500	Cones in fish examined very few and imperfect.		
Most	1-1100				
Eel	1-2700 to 1-1800	1-16,000 to 1-11,000	1-2700 to 1-1800	1-5500.	

On Triceratium *and some* New Allied Forms, *with figures of the same.* By Surgeon G. C. Wallich, M.D., Bengal Army. (Plates XII, XIII).

"The want of short characters," observes Professor Walker-Arnott, " (intended to place clearly before the mind the few essential points of difference between supposed new and already known forms or species) cannot be supplied by figures or diffuse descriptions of the entire object, as these leave quite in the dark the precise *marks of distinction* observed by the writer, if such actually existed."

To a certain extent this remark is true. But in the present state of our knowledge of that class of microscopic organisms to which Professor Walker-Arnott refers, its application is attended with so much difficulty, that, in the absence of somewhat detailed description, or accurate figures, the task of establishing clear views of special differences of structure becomes well nigh hopeless. Theoretically, it may be a matter of perfect simplicity to lay down definitions; and rules may be offered whereby, in the ordinary researches of natural history, such definitions shall be limited to a given number of words. But great obstacles present themselves in practice, where the microscope stands between the observer and the object he is analysing. To describe clearly and concisely what is seen by the unaided vision, may be an easy matter; but, in the case of organisms visible only under a high magnifying power, and which demand an experienced eye for their interpretation, the case becomes very different. It is here that illustrations afford the greatest possible assistance, and frequently accomplish in a moment what would otherwise demand hours of anxious and tedious labour. Good definitions are indispensable; but, under every circumstance, their value is much enhanced by well-executed figures.

We see this exemplified strikingly in the 'Synopsis of British Diatomaceæ.' Nothing can surpass the general conciseness of the definitions there given; but few will, I presume, deny that a number of instances might readily be cited, where those definitions would fail to convey the clear comprehension imparted by the masterly figures appended to them.

There is another reason why accurate illustrations are of the highest value. As the number of new forms increases, and data are thus afforded for revising errors of classification,

those figures become landmarks, and through them are afforded the means of ready comparison and reclassification.

In no family, perhaps, is the remodelling of characters, and, in this particular case, even of generic name, more necessary than in *Triceratium*. Recent additions to it clearly showing that outline, the character upon which it was originally, and, I may say, almost entirely, instituted by Ehrenberg, is not to be relied on; and that mere form may vary to a very great extent, whilst other characters, derived from important structural analogies, at once point out how little value is, in reality, to be attached to it. Two of the species I am now about to describe exhibit this circumstance in a remarkable degree; the one a normally four-sided, the other a normally five-sided form; but both, nevertheless, distinct *Triceratia*.

The first of these, to which I propose giving the specific name of *T. serratum*, was obtained by me at St. Helena, along with numerous other new and highly interesting forms of living Diatoms, in dredging at from twenty to thirty fathoms. Its characters are as follows:

Frustule free, constituting a four-sided prism. Valves quadrilateral, quadrangular—furnished with a horn-like process at each angle; and from four to six elongated spines furcate at their extremities. Connecting band composed of four quadrangular plates, joined together by regularly "dove-tailed" margins. These plates, in common with the valves themselves, marked with a delicate but well-defined hexagonal cellulation.

This form is remarkable chiefly for the very peculiar structure of its connecting membrane, which exhibits four distinct plates, having their communicating margins serrated, so as to fit into each other with accuracy. From this character the name is borrowed. The notches, or serræ, are rectangular. Across each plate, during division, there is to be seen an arcuate narrow band, along which the cellulation is interrupted. This band is expanded at its extremities. As division advances, each plate may be observed to consist of *two* layers, on the *concave* aspect of the arcuate band; which recede from each other; the upper one exhibiting the normal cellulation; whereas the lower (which is, in reality, a continuation of the other half of this plate) presents only a number of dots, the cellulation being imperfectly developed.

In a memoir by Mr. Brightwell, of Norwich, to which I shall again have occasion to refer, he mentions that the siliceous plates, forming the connecting membrane of the *Triceratia* generally, "are formed of several distinct layers of silex, dividing like the thin divisions of talc." These

layers, I believe, with all deference to so deservedly high an authority, are, however, rarely more than two, and arise from the plates, during the commencement of division, in the frustules of this and many other genera, always consisting of two pieces, which, at first, entirely overlap each other; but, as the process advances, recede from each other, and whilst so receding, appear like three distinct parallel annuli, the centre being less diaphanous, and its markings more confused, in consequence of its being, in reality, the overlapping and double portion referred to. This appearance has led to much uncertainty and doubt in descriptions of the connecting membrane, inasmuch as, from its transparent structure, markings when they exist in the lower plates, are seen through those in the upper. In those genera in which the valves assume at times a great relative depth, we find not only that the connecting membrane is more largely developed, but that the valves are furnished with a constricted rim, to which the margin of the annular plate is attached, as if to afford a more powerful point of resistance from whence it can extend itself. In *Amphitetras*, and certain species of *Triceratium* and *Biddulphia*, the existence of marginal rows of puncta on the annulus, in close proximity to the markings on its surface generally, proves that the growth of each plate of the connecting membrane takes place at the margin furthest off from the valve to which it is attached. Were it not so, the rows of marginal puncta would recede from the central markings, an effect opposed to what in reality occurs. Growth thus takes place in both plates at once—the overlapping, to a greater or lesser extent, being dependent on the rate at which the new valves within happen to be developed. In the newly separated frustule, one end may constantly be seen imbedded in its own half of the connecting membrane, which, for a time, remains attached to it. The same structure exists, I believe, in nearly all the genera, although more readily discernible in some than in others, from the greater facilities they afford as regards size and figure. It may be thus seen in *Himantidium, Odontidum, Denticula, Eunotia, Grammatophora, Amphitetras, Biddulphia, Isthmia, Melosira, Coscinodiscus, Hydrosera, &c.* I may observe, in passing, that the figures given in the 'Synopsis of British Diatomaceæ' of *Biddulphia, Amphitetras,* and *Isthmia,* show the general aspect of the connecting membrane—but without any allusion, on the part of the author, to the striking mode of development now described.

The arcuate bands are always arranged in the same direction, that is, their concave or convex aspects always face

towards the same extremity of the frustule on all four sides. Valve slightly convex on its surface; cornua well defined, and projecting in both front and end views; spines elongate, *not* marginally disposed; valve deeply constricted between the bases of the cornua and its free margin, which is everted; connecting membrane projecting boldly. Length ·0094; breadth ·0063; diameter of each side of valve ·0059 to ·0070. Cellulation 9 to 11 in ·001. Taking the characters given in the 'Synopsis' as our guide, it would be more easy to reconcile this form with *Amphitetras* than with *Triceratium,* inasmuch as "the cubical outline," to quote the text, "distinguishes it from all other forms." But in *Amphitetras,* the frustules cohere into a zigzag filament; the connecting membrane is imperfectly annulate and indefinite; the cellules are circular and inconspicuous at the angles of the valve. Whereas in the St. Helena species, the frustules never form a filament: the connecting membrane is definite and consists of four distinct plates; the cells on both the valves and connecting bands are similarly marked with a conspicuous and regular hexagonal cellulation; and lastly there exist the well-developed cornua and spines not seen in *Amphitetras.*

Again, viewed as a *Triceratium,* the chief distinguishing type of that genus falls to the ground; for whilst the species under notice occurs abundantly in the locality named, in no instance has a three-sided frustule presented itself. There must be some limit to type, and therefore when the character fails, as it is here shown to do, upon which the individuality of a genus in a great measure rests, the alternative remains of either cancelling that character, or of separating the form in which so constant an anomaly exists. In this instance it must be borne in mind that the four-sided form is therefore the typical one, and yet that analogies of structure clearly indicate its position amongst the *Triceratia.*

The nearest approach to its characters, I find in the '*Smithsonian Contributions,*' entitled 'Notes of New Species and Localities of Microscopic Organisms,' by Professor Bailey, of New York. A plate is there given of a frustule of *Triceratium setigerum* which, on a cursory examination, might be considered identical with the St. Helena Diatom. But, in the first place, it is to be inferred that the connecting band in that species offers no peculiarity, inasmuch as no allusion is made to such; and, in the next, the characters given indicate its distinctness, the "bases," as they are termed, "being triangular, bearing three large obtuse projections or horns, at the base of each of which is placed a setiform process."

Professor Bailey states that this form is allied to *T. spinosum*, which has been found in the fossil state in Virginia; but the same reasons that separates the St. Helena species from the *Triceratia*, of course apply equally to this.

In the valuable paper on *Triceratium* contributed to the 'Journal of Microscopical Science' for July, 1856, by Mr. Brightwell, three forms demand notice as being at first sight allied to the one under discussion, namely, *T. setigerum* of Bailey, *T. orbiculatum* of Mr. Shadbolt, and *T. formosum* of Brightwell, the last being the *T. armatum* of Mr. Roper.

Before noticing Mr. Brightwell's characters, I would draw your attention to a remark he makes on Professor Bailey having referred a four-sided form of *Triceratium* to the genus *Amphitetras*, namely, that "the projection of a connecting membrane beyond the suture of the valve, which is one of the characters of *Amphitetras*, is *not* seen in these square forms." A remark, if strictly accurate, at once fatal to any alliance between the St. Helena Diatom and those four-sided varieties, referred by Mr. Brightwell and others to the three-sided typical form.

In a former paper on the same genus, in the 'Journal' for July, 1853, Mr. Brightwell gives figures of three-, four-, and five-sided varieties of *T. striolatum*, a name he alters in the recently published memoir into *T. formosum*, already alluded to. Now in none of these does the connecting membrane project in the slightest degree. The colour of the frustule is moreover pale brown, indicative of very minute cellular structure, whilst the horns are simple projections, and no spines exist on the surface of the valves; and lastly it is very much smaller than *T. serratum*.

Amongst Mr. Brightwell's species, *T. armatum* comes nearer to the St. Helena form than any of the others. Mr. Roper, to whom we are indebted for a description of this species, thus characterises it in the 'Microscopical Journal' for July, 1854:

"Frustules large, with straight or slightly convex sides. Angles produced into horn-like processes, with rounded extremities; cellular structure minute, partially radiating towards the sides and angles; six or more spurious processes projecting from the surface of the valve." Mr. Roper's specimens are described as approaching closely to *T. tridactylon*, of Ehrenberg, a form also figured by Mr. Brightwell. But he states that *T. armatum* is deficient in the siliceous plate that is shown to exist around the sides of *T. tridactylon*. Mr. Roper thinks his specimens are not identical with Professor Bailey's *T. spinosum*, whereas the spines are shown,

both in Mr. Roper's and Mr. Brightwell's figures, to be submarginal.

Mr. Brightwell again figures several varieties of *T. armatum*. The first being the only one that in the least resembles the St. Helena form. But his figure is represented as being the front view of that described by Mr. Roper, which has already been shown to be distinct, and is clearly proved to be so, from the other figure given of a front view of a four-sided specimen, in which the cells are circular; the connecting membrane is marked as in *Amphitetras,* and its margin exhibits a bold fimbriated border.

The next form to which I shall refer is a very large and beautiful *Triceratium,* obtained by dredging at St. Helena, in form thirty-five to forty fathoms, and to which I propose to give the specific name of *T. fimbriatum*.

Its characters are as follows:

Frustule three-, rarely four-sided; sides convex; angles furnished with short cornua; cells large, hexagonal; marginal border between horns furnished with a series of two-lobed flabelliform and pedunculated fimbriæ; connecting membrane marked with diamond-shaped striation.

The circlet of remarkable fimbriæ at once serves to distinguish this species. These arise from the outer edge of the marginal row of cells, by delicate pedicles, which immediately expand into broad flabelliform discs, having their flat surfaces parallel to the margin of the valve, and divided down their centre by a deep notch. These fimbriæ are very similar in outline to the architectural decoration called "Greek tiles," which are small separate mouldings, placed at intervals on the cornice of a building, along the side of the roof, and serve to conceal the ridge formed by the overlapping of the roof tiles. In some frustules there exist also, at each angle of each hexagonal cell, minute dot-like processes (recently figured by Mr. Roper as existing in *Eupodiscus tesselatus*), which, seen in profile when a portion of the valve is broken up, prove to be minute discs of similar character to the fimbriæ just alluded to.

This species has, however, another peculiarity which would render the specific name of *favus* especially applicable, had it not been already assigned to the typical species, to denote the similarity, in superficial aspect only, of the hexagonal markings to the honey-comb. Each hexagon in the St. Helen form being, not merely a simple depression dependent on the mode in which the siliceous element is secreted by the inner cell-membrane on its own surface, but a deep hollow cell, with perpendicular sides, of sufficient depth to be

readily measured, when seen in fragment and in profile; and which, *à priori*, indicates the presence throughout each cell of the membranous structure from which it is thus deposited. The floor of these cells is also minutely punctate, the puncta being arranged in quincunx.* The minute puncta only require careful illumination and a power of 400 diameters to render them quite distinct. At first sight the double outline visible in the hexagonal cells, as seen in certain positions, might be considered as due to refraction. But, on obtaining a fragment in an oblique position, the perspective view of the receding cells leaves no doubt of their true character. I would observe that similar cellulation appears to me to exist in other discoid forms, although too minute to be as readily interpreted.

On a side view of the valve, below the outer series of cells, a single row of small rectangular markings is observable. The valve is slightly constricted around the margin. The horn-like processes are directed upwards, as in *T. favus*, but do not project beyond the angles. The constant character of the outline of the valves in this species is remarkable, inasmuch as it answers to the figure formed by describing an arc of a circle, with a radius equal to the magnified diameter of one side of the valve; taking off, on that arc, the same radius, and describing a second and like arc; and, lastly, making the point of intersection thus obtained the centre wherefrom to complete, with still the same radius, the third arc, or side of the figure required.

The measurements are—

Diameter of each side of valve, from ·0047 to ·0175; diameter of each cell ·00034; cells $3\frac{1}{2}$ in ·001; depth of hexagonal-cell-walls ·00026; length of fimbriæ ·00046; breadth the same; striation on connecting band 48 in ·001.

Although, in general character, this species is no doubt closely allied to *T. favus*, the remarkable cell-structure and fimbriated border sufficiently distinguishes it.

Mr. Brightwell, in the 'Journal of Microscopical Science' for July, 1853, p. 249, describes a new species by the name of *T. grande* and to this a figure is appended which, in the end view, is very similar to *T. fimbriatum*. But *T. grande* has no border, whereas *T. comptum*, also described and

* This basal plate, when the valve is fractured, presents a remarkable and somewhat obscure feature, inasmuch as its line of fracture does not always correspond with that of the valve generally, and would thus appear in some measure distinct—a fact which I cannot help thinking has led to such lower plate in some of the discoid forms being looked upon as distinct species.

figured in the same place, under the sub-tribe with "angles spinose," is much smaller, has nearly straight sides, but exhibits "a projecting fringe, stated to *consist of oval depressions*." Specimens of *T. comptum* in my possession, obtained from Californian guano, clearly correspond with Mr. Brightwell's, and corroborate the distinctions from *T. fimbriatum*.

Mr. Roper, in the Journal of the Society for July, 1854, p. 283, gives a figure also of *T. comptum*, Ehr., which he states as having "a row of *cells* projecting above the margin of the valve; sides straight or slightly convex, the horn-like processes short and obtuse; and cellular structure large." But although Mr. Roper is doubtful whether his specimen may not be a young form of *T. favus,* he leans to the opinion that the length of the angular processes and fringe-like row of cells appear to give it a distinctive character.

The next form is from brackish water in the Delta of the Ganges, and is undoubtedly new. I propose to call it *T. annulatum*. The characters are—Valve minute, triangular; angles slightly produced, rounded; sides slightly concave; tri-radiate, and having its surface covered with minute puncta; the more close aggregation of which, in concentric rings around the common centre, gives the valve an undulated appearance.

The rays are thickenings of the siliceous epiderm which pass from the centre of the valve outwards in the direction of each angle, gradually becoming fainter as they approach the latter. In like manner the puncta are more numerous and are more closely aggregated as they approach the central portion; whilst, at the extreme angles, the markings are almost entirely wanting.

Diameter of each side ·002.

The next species, which I propose to call *T. pentacrinus,* although normally a five-sided form, is also distinctly referable to that genus. It was obtained off St. Helena, in thirty fathoms water, in a living condition. The characters are as follows:

Frustule free, constituting a pentangular prism; valves somewhat convex, pentangular, each side deeply convex; with short stout cornua at each angle. Surface spinous; divided into compartments, by interrupted bands, which radiate irregularly from the centre, and inosculate laterally with each other. Cellular structure minute, consisting of circular dots. Connecting membrane annulate, indefinite, marked with dots arranged in quincunx, and which become more minute as they advance from the margin towards the median line of the annulus, and are partially interrupted at the

angles. Around the margin a row of oblong cells, placed side by side.

The peculiar ribbed character here seen is conformable to that shown, in a modified degree, in several already described species. For instance, in the July number of the Society's Journal for 1856, Mr. Brightwell characterises and figures no less than nine forms, all of which present the ribbed structure more or less. To these markings, in some of the forms, Mr. Brightwell applies the term of "*canaliculi*." In the form under notice now, the ribs are, however, simple thickenings of the siliceous epiderm, which are neither tubular, nor dip down at all into the cavity of the frustule, so as to form pseudo-septa. The puncta are arranged in rows following the radiate direction of the ribbed partitions referred to. The horn-like processes appearing more like inflated prolongations of the angles of the valve, the apices being minute and capitate. Valve constricted deeply between the bases of the horns and its margin. Spines numerous, irregularly placed, short and furcate. Connecting membrane projecting boldly, hyaline, with the undulating outline given by the form of valve, and its concave margins inflected.

Diameter of frustule ·0023; depth about ·0020.

I have met both with four- and six-angled varieties of this species; but these are rare. The first is not unlike that figured by Mr. Shadbolt in the Society's Journal for October, 1853, p. 17; but as the front view is not given, it is difficult to say positively whether the two are identical. Mr. Shadbolt describes his species as "having the margins of the valves considerably hollowed out or emarginate, and folded over so that each valve is not unlike in form to a collegian's cap. The surface being elegantly but somewhat irregularly ornamented with delicate markings."

Two remarkable Diatoms remain to be described in this paper, the characters of which, I believe, are essentially new. For although, at first sight, one of the species appears allied to the filamentous *Triceratia*, its marked identity in structural peculiarities with the second, which is obviously distinct, leaves no reasonable doubt on the subject.

Again, the second form, under a cursory examination, might be referred to *Biddulphia*, but its unquestionable affinity, as I apprehend, to the first, would, with equal force, separate it from that genus. In both cases another and very conclusive example being afforded of the small real value that attaches to definitions based on mere outline.

The species to which I allude were obtained by me from the Gangetic Sunderbunds, in brackish water, well within

influence of the tides; and were found growing attached as a soft mossy stratum upon submerged Algæ or tree stems. From the beautiful jointed-looking filaments, I have designated the genus by the name of *Hydrosera*. The characters are as follows:

Frustules attached, forming elongated direct filaments. Frustules either triangular prisms or compressed cylinders, attached to each other at each angle by a mucous cushion. Valve cellular, furnished with perfect septa; and, on *one side only*, with a remarkable series of aperture-like appendages. Connecting membrane quite plain; hyaline.

Although the association of the triangular with the compressed form may, at first sight, appear untenable, the other characters common to both, and more especially the remarkable processes observable on *one* side only of each valve, appear conclusively to establish the fact of their ranking under the same genus. The two species I have named respectively *H. triquetra* and *H. compressa*.

The specific characters of the first are as follows: Frustule a three-sided prism, having a portion of each angle partitioned off by a septate process, which is partly given off from the inner wall of the valve itself, and partly, as in *Rhabdonema* and *Mastogloia*, from the connecting membrane. Valve triangular, sides undulated, surface reticulated. Angles rounded, obtuse, and smooth, but furnished with two or three stout minute spines. On one side only of each valve, at the central portion of its outer margin, from two to five minute punctate appendages exist. Connecting membrane compound, its outer annulus exhibiting a continuation of the valvular septa, plain, annulate and undulate. Front view of frustule a parallelogram, rather longer than broad when not undergoing division. F.V. length, from ·0017 to ·0050 Breadth, the same. E.V. diameter, the same. Cellulation from 9 to 13in. ·001.

The punctate appendages are visible also in F.V. on both valves on same side of the frustule; and in the filament, on the same side throughout. Around them the siliceous epidermis thickened. Free ends of the septa of valve hollowed out, the cusps resting on imperfect septate processes given off from the connecting membrane. The outer margin of the latter much thickened, and giving to the F.V. the appearance of a siliceous hoop encircling the margin of each valve. Connecting membrane, of two plates or hoops, during division, as mentioned in Tuceratium. The spines at the angles very minute, and requiring careful illumination, with a power of from 300 to 400 diameters, to bring them

out clearly. They are probably of use in strengthening the mucous cushion whereby the angles are held together; the filaments being remarkably tenacious. Frequently composed of from thirty to forty frustules.

The frustules vary greatly in size, but never in general contour, although the sides are at times more inflated than at others. The side exhibiting the punctate processes being generally the most convex. In like manner the angles are sometimes acute, sometimes subacute; an angular bend existing in the end view, where the septa coalesce with the margin. Cellular structure thickest at centre of valve, and varying to a limited extent in coarseness, although always large and easily seen in this species. Under a power of 200 diameters, the marking seems minutely cellular; but amplified to 400 diameters, it is shown to consist of a number of large reticulated polygonal spaces, having a tendency to the hexagonal character, and divided by narrow lines or ribs, which coalesce with each other. Entire frustule perfectly siliceous. Endochrome equally distributed, granular, and of a pale but rich green.

In *H. compressa* the characters are:

Frustule, a compressed cylinder, forming lengthened filaments, as in *H. triquetra*. Valve elliptical, sides undulated. Angles subacute. Valve in E.V. divided into three compartments by two septa thrown across it. Angles smooth and occasionally exhibiting two or three very minute spines, as in the former species. The punctate appendages on one side only. Connecting band plain, annulate, undulate, indefinite. F.V. as in *H. triquetra*, a parallelogram, with subacute angles.

In the front view the three compartments are inflated; the central one being the largest. Ends full, rounded, and hyaline, with no trace of cellulation.

F.V. Length of frustule, ·0017 to ·0048; breadth, ·0017 to ·0048. S.V. length, from ·0017 to ·0048; breadth, ·0006 to ·0014. E.V. length, from ·0017 to 0048. Breadth of central compartment, ·0017 to ·0034. Breadth of terminal compartment, ·00086 to ·0014.

It is difficult to suggest, with any approach to certainty, the purposes subserved by the unsymmetrically placed lateral processes alluded to. But, in all probability, they are analogues of the central and terminal nodules of other diatoms. On a future occasion, I hope to offer some remarks on the peculiarity they present, and to point out more particularly their resemblance to the unsymmetrically placed puncta in *Gomphonema geminatum*, and in two new Indian species of

Cocconema and *Gomphonema*, which are, in like manner distinguished by these remarkable appendages.

The only genera with which *Hydrosera* can at all be confounded, are—*Terpsinoë* of Ehrenberg, *Anaulus* of the same author, and *Tetragramma* of Professor Bailey; the last being in reality, however, nothing more than a variety of *Terpsinoë musica*, and therefore not demanding further notice.

In *Terpsinoë* the frustules are described as "*tabular* and obsoletely stipitate," a character which might apply to *H. compressa*, but which at once fails in *H. triquetra*. The filaments, however, assume a "zig zag" form, and the cellular structure is "*very minutely punctate*," with no appearance of reticulation.

I admit that it was a question resting chiefly on how far *H. triquetra* can be safely separated from *H. compressa*, that induced one to remove the latter species from *Terpsinoë*, to which it bears a strong resemblance in its "tabular" or rather compressed form, but from which it differs materially in the presence of the lateral appendages, the spinous angles, and the direct nature of its filament.

In *Lithodesmium* the valves are described as triangular, but they are distinguished from those of the present genus by their "extreme smoothness," transparency, and their not being cellulate. Two sides only being symmetrical and "undulated," whilst the third "is doubly excised or notched."

Lastly, in *Anaulus* "the frustules never form a filament, but are single, and neither furnished with tubular processes, nodules or apertures.* The separation of Hydrosera is however completed, I submit, by the presence of the very remarkable appendages I have described, and which afford a character so very distinct from what is to be seen in any other alluded genera.

* *Vide* 'Micrographic Dictionary,' and Kützing, "Species Algar."

REVIEWS.

Clinical Lectures on the Principles and Practice of Medicine. By John Hughes Bennett, M.D., F.R.S.E. Edinburgh: Adam and Charles Black.

Although this is a second edition of a work well known, and its main purpose beyond the sphere of our criticism, we think it right to bring it before the notice of our readers, because it contains a large amount of matter bearing directly on microscopic research. Dr. Bennett is one of those teachers of medicine, who has, from an early period of his career, recognised the importance of conducting pathological researches by the aid of the microscope, and in this work abundant evidence is afforded of the value and necessity of this instrument to the practitioner of medicine. In an early number of this Journal (volume I, page 223), we reviewed Dr. Bennett's 'Introduction to Clinical Medicine,' and recommended it to the notice of our medical readers, as conveying a just estimate of the value of the microscope in pathological research. In the present work the practical application of this instrument to the various forms of disease in which it may be employed is fully brought out. In fact, with regard to a large number of the forms of disease no true theory of their nature can be formed independent of an investigation by the aid of the microscope. It is in the section devoted to the principles of medicine that Dr. Bennett handles the facts supplied by microscopic research in the most masterly manner. This section should be studied by all those who are anxious to understand the intimate causes engaged in the production of disease, and what are the changes which are necessary to the establishment of health. We should not pretend, even had we space here, to criticise Dr. Bennett's theoretical or practical conclusions from the observations he records, but we draw attention to them, as showing the comparative valuelessness of any observations or deductions on the intimate nature of organic disease without microscopic investigation.

We select two passages from this section of the work on exudation and degeneration, not on account of any novelty they present, but as illustrations of the manner in which the subject of pathology is treated.

"Tubercular exudation has been spoken of as presenting a miliary infil-

trated or encysted form; but these distinctions have no reference to structure, but merely to the extent and age of the exudation. It generally presents a yellowish or dirty-white colour, and varies in consistence from a substance resembling tough cheese to that of cream. Sometimes it is soft at one place, and indurated at another. On section, when tough, it presents a smooth or waxy, and when soft, a slightly granular surface. On pressure it is friable, and may break down into a pulpy matter, but never yields a milky juice.

"A small portion squeezed between glasses, and examined under the microscope, presents a number of irregular shaped bodies approaching a round, oval, or triangular form, varying in their longest diameters from the 1-2000th to 1-1200th of an inch. These bodies contain from one to seven granules, are unaffected by water, but rendered very transparent by acetic acid. They are what have been called tubercular corpuscles. They are always mingled with a multitude of molecules and granules, which are more numerous as the tubercle is more soft. Occasionally, when softened tubercle resembles pus, constituting scrofulous purulent matter, we find the corpuscles more rounded, and approaching the character of pus-cells. They do not always, however, on the addition of acetic acid, exhibit the peculiar granular nuclei of these bodies.

"The gray granulations described by Bayle may be seen on careful management of the light, after the addition of acetic acid, to contain similar bodies to those described as tubercle corpuscles, closely aggregated together, with their edges indistinct, and containing few granules.

"Cretaceous and calcareous tubercles, on the other hand, contain very few of these bodies, their substance being principally made up of numerous irregular masses of phosphate of lime, and a greater or less number of crystals of cholestrine.

"Tubercle corpuscles may be associated with pus and granular cells, as well as those peculiar to glandular organs or mucous surfaces in various stages of fatty transformation and disintegration. With all these they have frequently been confounded." (pp. 143, 144.)

Fatty Degeneration of Muscle.—"There can be no doubt that the fibro-albuminous substance constituting flesh is capable of undergoing a transformation into fat. Of the exact chemical nature of that transformation we have yet to be informed; but it may not only be observed in the dead body, but may be produced artificially, by exposing muscle to a running stream of water, whereby it is changed into adipocere. In voluntary muscle, we observe that the degeneration commences with diminished distinctness of the transverse striæ, especially at the circumference of the fasciculus. As this extends inwards, minute molecules of fat occupy the position of the striæ, and at length obliterate them; gradually these coalesce, globules of various sizes are formed within the sarcolemma, and the normal structure of voluntary muscle disappears. During the early changes the fasciculus becomes soft, exhibits a tendency to crack crossways, and ultimately is so pulpy as to be capable of being squeezed easily into an amorphous mass, from which large oil-drops exude. To the naked eye, the muscular substance becomes paler, and more and more fawn-coloured, and at length yellow, whilst its normal density is greatly diminished. These changes are easily observed in the heart, in which organ they have been made the subject of special research by Ormerod, Paget, Quain, and others. The histological and clinical researches of Dr. Quain on this subject are of the greatest importance.

"All the voluntary muscles, however, are susceptible of undergoing a similar lesion, and it may be not unfrequently seen in those of the lower extremity after long-continued paralysis, disease of the hip-joint, or other

lesions which necessitate immobility of the parts. In this case, and occasionally in the heart itself, in addition to the transformation of the muscular fasciculi above described, adipose tissue accumulates between them, and by compressing their substance adds to the rapidity and completeness of the transformation. In such cases the muscles are of a pale yellow colour, yielding on section large quantities of oil, while they preserve their usual form and fibrous look. I have seen all the muscles of the lower extremities so affected. Occasionally, while some muscles exhibit this transformation in its last stage, others close beside them present their normal red colour, so that the limb on dissection resembles the alternate red and fatty streaks of bacon. In this case the degenerated muscle has the whole of its fasciculi transformed into adipose cells, with nuclei.

"In involuntary muscles fatty degeneration may also be observed, although it is by no means so common as in voluntary ones. In this case, oily molecules are deposited in the elongated fusiform cells of which the texture is composed, which by their pressure on the nucleus cause its disappearance. Whether the distended pregnant uterus shrinks to its normal proportions after delivery wholly in consequence of such a degeneration (Heschl) is a point not yet determined in pathology. But there can be no doubt that many of the greatly enlarged fusiform cells of the organ, do become more or less crowded with fatty granules." (pp. 226-228.)

In his preface, Dr. Bennett states that he has "been long persuaded that mere description of morbid appearances, and especially of those that are made visible by means of the microscope, communicate only feeble or imperfect ideas to others." He has accordingly abundantly illustrated his work with wood-engravings, of which there are nearly five hundred in the volume, mostly devoted to microscopic appearances. This work will, we are sure, greatly enhance the reputation of Dr. Bennett as a practical pathologist, and find its way to the study of every scientific practitioner of medicine.

Illustrations of the Constituents of Urine, Urinary Deposits, and Calculi. By Lionel S. Beale, M.B., F.R.S. London: Churchill.

The object of Dr. Beale in preparing these illustrations has been to place in the hands of medical students and practitioners of medicine, at a moderate price, a series of correct representations of the various deposits found in healthy and morbid urine, as well as of salts held in solution, or formed by chemical re-agents in this secretion. The work contains thirty-seven plates, with upwards of one hundred and seventy figures and accompanying letter-press, and seems well adapted to secure the object Dr. Beale had in view in its publication. It embraces almost all possible forms of objects that could be presented to the student in connexion with the urine. It is also accompanied by a frontispiece and woodcut, illustrating the anatomy of the kidney.

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *April 21st*, 1858.

Dr. Lankester, President, in the chair.

General Alexander, Henry Carr, Esq., and Dr. G. Walker were balloted for, and duly elected members of the Society.

The following papers were read:

"On some Diatomaceæ found in *Noctiluca miliaris*, with the best means of obtaining them," by Colonel H. H. C. Baddeley.

"Note on *Campylodiscus Hodgsonii*," by Dr. G. A. Walker-Arnott.

"Account of Microscopical Observations and Collections made during a residence in India, and the voyage home," by Dr. Wallich, illustrated by a large collection of drawings and objects.

May 19th, 1858.

George Jackson, Esq., in the chair.

Dr. Wallich, W. T. Rickard, Esq., Rev. R. S. Bower, and Dr. F. Bossy were balloted for, and duly elected members of the Society.

Mr. Roper read a paper "On the Genus Biddulphia and its Affinities."

June 16th, 1858.

Dr. Lankester, President, in the chair.

Thomas Leonard, Esq., and John Smith, Esq., were balloted for, and duly elected members of the Society.

H. W. Lobb, Esq., read a paper "On the connecting link between the Animal and Vegetable Kingdoms."

Papers by W. Hislop, Esq., "On a new Secondary Stage," and by Captain Mortimer Slater, "On certain new forms of Butterfly Scales from India," were read.

The President made some remarks on the occurrence of

Protococcus pluvialis in large numbers in a pond near Harleston, Norfolk, and exhibited specimens.

A paper by Fitzmaurice Okeden, Esq., "On the Diatomaceæ of the South of Wales," was read, illustrated by 214 mounted specimens of Diatomaceæ, which were presented to the Society. The special thanks of the Society were returned to Mr. Okeden for his valuable present.

The meetings of the Society were then adjourned until October next.

Some difficulties having occurred in the practical application of Whitworth's gauges recently recommended by the Society for the purpose of establishing an uniform screw for object-glasses, it was *resolved,* at the meeting of the Society on May 19, that "Two dozen steel taps be made for the use of makers of microscopes, wishing to adopt the universal attachment for object-glasses recommended by the Society."

If one of these taps be made to enter the body of the microscope, it will receive any object-glass having a screw of the dimensions recommended, and the cylindrical gauges will not be required.

The set of taps is in course of construction, and may in a few days be obtained of Mr. Williams, the Assistant-Secretary to the Astronomical Society, Somerset House, at the price of 5*s.* each.

Dublin Natural History Society, *May 7th,* 1858.

The President in the chair.

The Rev. Eugene O'Meara read the following paper, "On the occurrence of Anthozoids in *Pleurosigma Spencerii.*"

"On Friday evening, April 30th, I was engaged in the examination of a gathering I had made two days previous from a running stream. On looking into the microscope I was much struck with the peculiar appearance of one of the forms that first presented itself in the field, a *Pleurosigma Spencerii.* The usual colour of the endochrome in this species is pale brown, but in the present instance it was a beautiful green. A number of granules of a bluish-green colour were distributed through the cell. In a few minutes I observed that the greater portion of the granules, at least

two thirds, moved with a sudden jerk to the lower part of the cell. Some of the granules passed out of the valve, and immediately after an anthozoid issued from the cell. Shortly after another made its appearance, and another, until six or eight had been extruded. All these organisms proceeded in the same manner from the valve, and exhibited themselves in the same spot, within, what appeared under a quarter-inch objective with No. 2 eye-piece, about one sixteenth of an inch from the extremity of the valve. In form the anthozoids, if at rest, would have presented very much the appearance of a spike of thistle-down.. The head was of a pale-green colour, and round it the tail was lashed from side to side with great activity. On the same occasion several forms were observed presenting similar appearances, with anthozoids moving rapidly about in their immediate neighbourhood. Among these were two or three of the species named *Cymatopleura Solea,* but in no case, except the one just alluded to, did I observe them issuing from the valve. On the evening following that in which the preceding observation was made, I examined a drop from the same gathering, when a great change was noticed to have taken place in the appearance of such Diatomaceous forms as occurred, compared with that which they presented the evening before. But few granules were seen. The endochrome also had changed its colour from green to olive, and instead of being diffused through the cell, was, in many instances, collected to a narrow band along each side of the cell, or at the opposite ends of it. In some cases these bands had broken up into isolated portions, and in others the valve was as free from endochrome as if it had been treated with acid."

The President dwelt on the necessity for repeating this observation, and suggested whether these were anthozoids or spermatozoids. In either case the observation was perfectly new, and would therefore most probably be disputed; and therefore there was the greater necessity for repeating, and, if possible, confirming the observation, and the more glory should this discovery be confirmed.—*Dublin Paper.*

ZOOPHYTOLOGY.

Notes *on two* New British Polyzoa. By Fred. D. Dyster, F.L.S.

Sub-class. P. gymnolæmata.

Order. Cheilostomata.

1. Fam. Bicellariadæ, Busk ('B. M. C.,' Part I, p. 41).

1. Gen. *Huxleya*, nov. gen., mihi.

Polyzoary flexible, corneous or sub-calcareous. Cells biserial, pyriform, alternate. Aperture small, sub-terminal, unarmed. No avicularia or vibracula.

1. Sp. *H. fragilis*, n. sp. Pl. XXI, figs. 1, 2. Sp. unica.

Hab. Tenby, Dyster.

The polyzoary, in this species, is from half an inch to one inch high, flexible, and white. The cells wider and rounded above, attenuated below; the upper portion of one being closely appressed to the slender lower part of the cell above. The dichotomous branches usually spring from the upper and back part of a cell, and occasionally, though rarely, from the middle or side. The aperture is small, rounded or semicircular above, and straight below. The margin is wholly unarmed, and not thickened. No vibracular or avicularian organs exist in any part. The ovicells have not been observed. The polypide is ten-armed. The species was first noticed by me in a marine aquarium.

2. Fam. Scrupariadæ, Busk ('B. M. C.,' Part I, p. 28).

2. Gen. *Brettia*, nov. gen., mihi.

Polyzoary erect, free, corneous, flexible. Branches given off behind and above the aperture of a cell.

2. Sp. *B. pellucida*, n. sp. Pl. XXI, figs. 3—5.

Hab. Tenby, Mrs. Brett; Dyster.

The polyzoary, about half an inch high, is perfectly transparent; the cells are much elongated, fistular, with an oval aperture, rounded above, pointed below, and furnished with from five to nine marginal spines, irregularly placed. The polypide has ten arms; and the ovicells have not been observed. This species was also first noticed in a marine aquarium by Mrs. Brett.

It is singular that neither of the foregoing forms should

have been detected in their natural habitat. The *Huxleya* grew in a tank of my own filled, of course, with water from the Bay, which had not been changed for many months. The other beautiful Polyzoan was found by my friend Mrs. Brett, in a tank devoted to *Actiniæ*, but of which the water was changed pretty frequently.

I had long observed the presence of the *Huxleya* in my tank, but fully believing it to be *Eucratea chelata*, had never taken the trouble to examine it, and, unfortunately, when I did so, the polypides were dead, and nearly decomposed. They appear to communicate very freely with the general sarcode of the polyzoary, as much so as in Laomedea and other hydroid Polypes. The retractor muscles are very long. The nearest form to *Huxleya* would probably be *Halophila*, Gray ('B. M. Cat.,' p. 43, pl. xxx).

In the case of *Brettia*, its discoverer laid it aside after gathering it, and it was not examined till after death; but there is no reason to suppose that there is anything distinctive about the polypide.

On some Madeiran Polyzoa.
Collected by J. Yates Johnson, Esq.
(*Continued from* No. XXII, p. 129.)

We here give figures and descriptions of some species of Madeiran Polyzoa, additional to those contained in a former part of the Journal.

1. Fam. Bicellariadæ, Busk.

1. Gen. *Bugula*, Oken.

1. *B. ditrupæ*, n. sp., Busk. Pl. XX, figs. 7, 8.

Cells biserial, elongate, fusiform. Aperture wide, elongated, with two or three marginal spines on the outer and one on the inner side of the aperture above. Avicularia capitate, attached to the side of the cell below the middle.

Hab. Madeira, Johnson. On the shell of *Ditrupa acuminata*.

The present species is distinguished from *B. flabellata* by the biserial arrangement of the cells, and from *B. dentata* by their elongated and fusiform shape. Independently, however, of these characters, the general habit and very peculiar site of growth of *B. ditrupæ*, formerly noticed, would alone suffice to indicate its specific independence.

2. Fam. MEMBRANIPORIDÆ, Busk.

2. Gen. *Membranipora,* Blainville.

1. *M. antiqua,* n. sp., Busk. Pl. XX, figs. 1, 2.

Area of cell pyriform, irregular, arched above, and either pointed or truncate below. Aperture sub-trifoliate, or somewhat contracted on the sides below the middle. Septa simple, not grooved. Numerous vibracular cells irregularly scattered throughout the polyzoary among the others, of an ensiform or falciform figure.

Hab. Madeira, Johnson (on shell).

A considerable number of fossil species of *Membranipora,* and several of *Eschara,* are characterised by the presence in various points of the polyzoary of cells differing in form and size from the common polypide-cells. From analogy with similar cells in several species of Lunulites, which are known to be vibracular organs, there is little or no doubt that the cells in question in the *Membraniporæ* and *Escharæ* are of the same kind. And this supposition is further confirmed by the circumstance, that in *M. stenostoma,* Busk ('B. M. Cat.,' p. 60, pl. c, fig. 1), avicularian cells are present, similarly disposed with relation to the polypide-cells.

This peculiar character in the present species, by which it is distinguished from all other recent *Membraniporæ* with which I am acquainted, with the single exception above noticed, renders it a form of particular interest, when compared with many fossil species, occurring as it would seem in the Cretaceous formation. Instances of these will be found in the 'Paléontologie Française' of M. D'Orbigny, and more especially in the forms described and figured as—

Cellepora Xiphia, pl. dccxiii, figs. 3, 4.
,, *Xanthe,* ib., figs. 5—7.
,, *Michaudiana,* pl. dccxii, figs. 3, 4.
,, *Xelimia,* ib., figs. 15, 16.
,, *Parisiensis,* ib., figs. 13, 14.
Semieschara simplex, pl. dccix, figs. 1—4.
,, *excavata,* dccx, figs. 6—9.

As well as in Hagenow's 'Bryozoen der Maastrichter Kreidebildung,' in the forms denominated—

Cellepora Koninckiana, pl. xi, fig. 10,
,, *depressa,* ib., fig. 13,
,, *camerata,* ib., fig. 9,

and others.

3. Gen. *Lepralia,* Johnston.

1. *L. sceletos,* n. sp. Busk. Pl. XX, fig. 3.

Outline of cell oval; anterior wall constituted of rib-like spines, six or seven on each side, which meet and interdigitate on the median line. An

ascending spine at each lower angle of the aperture. Avicularia of a blunt, rounded, elliptical form, scattered over the polyzoary among the cells.

Hab. Madeira, Johnson.

A very peculiar and well-marked species, characterised not only by the skeleton-like appearance of the cells, some resemblance to which may be occasionally observed in *L. nitida*, but more especially by the large blunt avicularia scattered irregularly among the cells, as in *L. monoceros*, Busk, and *L. margaritifera*, Quoy and Gaim ('B. M. Cat.,' pl. ci), in which latter the avicularia, though far smaller, are of pretty nearly the same shape as those of *L. sceletos*.

2. *L. radiata*, Moll. Pl. XX, figs. 4, 5. ('Quart. Journ. Micros. Sc.,' vol. vi, p. 128.)

3. Fam. CELLEPORIDÆ.

4. Gen. *Cellepora*, Fab.

1. *C. Hassallii* (var. *a*). Pl. XX, fig. 6.

The only difference apparent between the present form, and that taken as the typical species in the 'B. M. Cat.,' p. 86, pl. cix, figs. 4, 5, 6, is the absence in it of the punctures in the ovicell. Whether this is alone sufficient to constitute a specific distinction, may be considered doubtful. For the present, I am inclined to regard the Madeiran form simply as a variety of the British.

ZOOPHYTOLOGY.

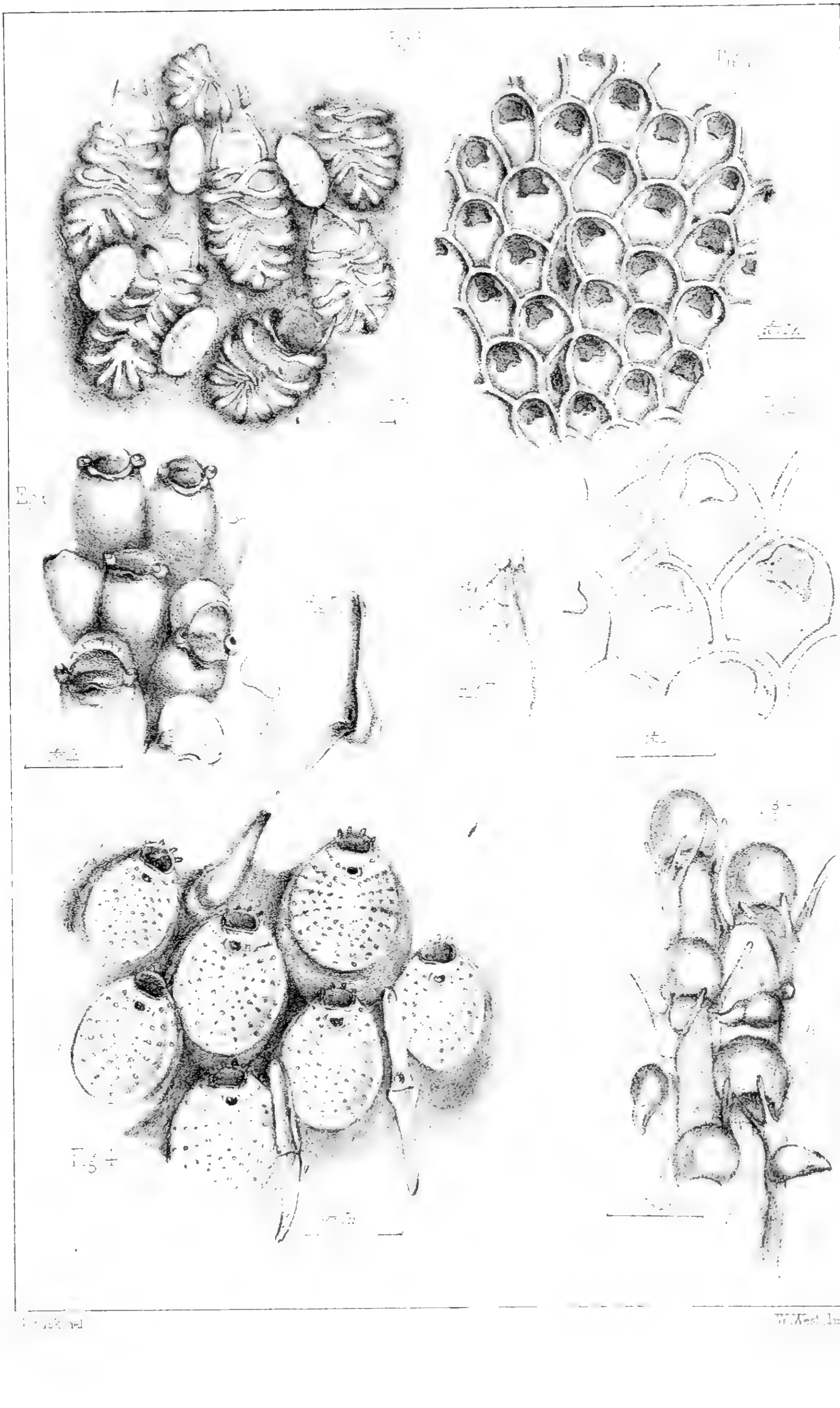
DESCRIPTION OF PLATES.

PLATE XX.

Fig.
1.—*Membranipora antiqua*, × 25 diam.
2.— ,, ,, × 50 d.
3.—*Lepralia sceletos*, × 50 d.
4.— ,, *radiata*, × 50 d.
5.—An avicularium of *L. radiata*.
6.—*Cellepora Hassalii* (var. α).
7.—*Bugula ditrupæ*, nat. size.
8.— ,, ,, × 50 d.

PLATE XXI.

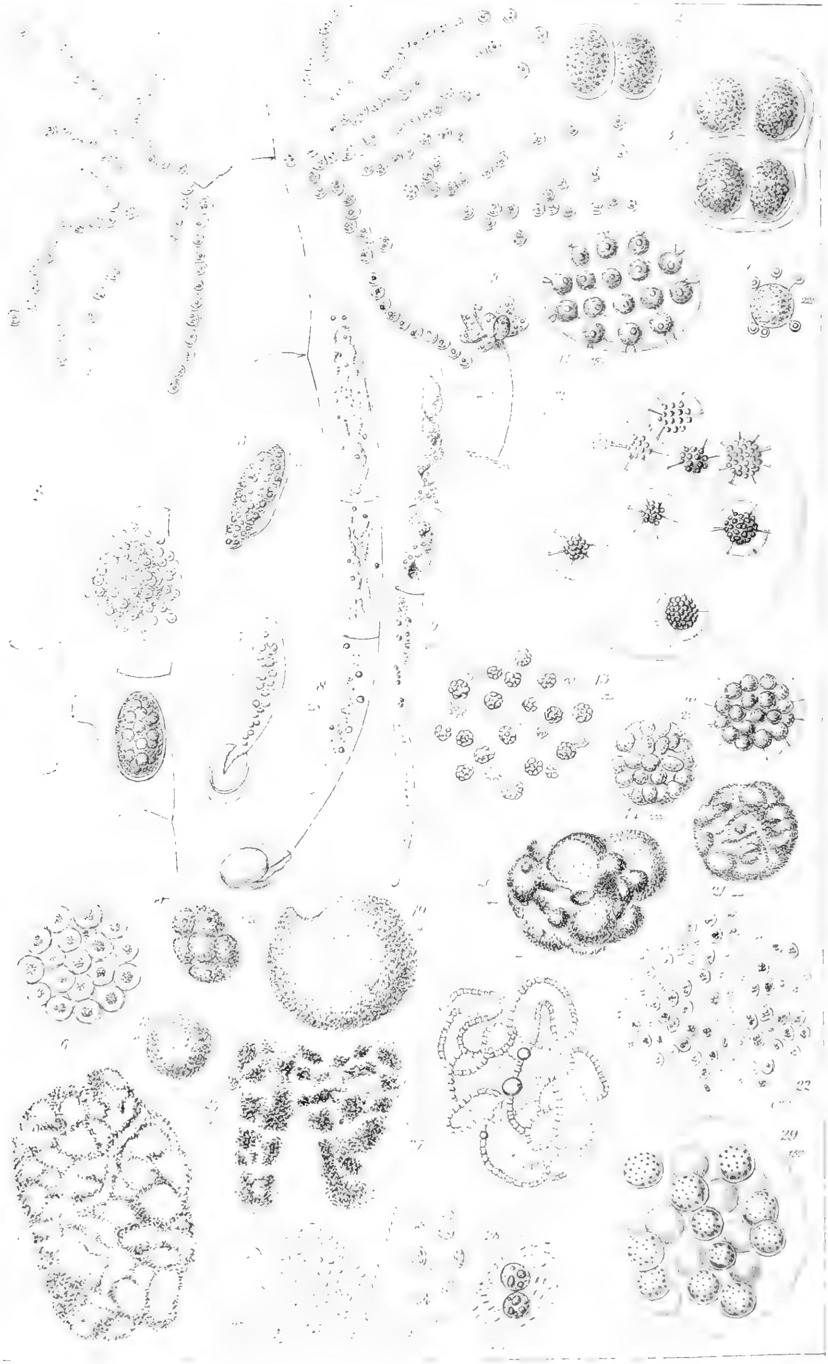
1, 2.—*Huxleya fragilis*.
3—5.—*Brettia pellucida*.



W. West. Imp.

G.Busk, del.

W.West, Imp.



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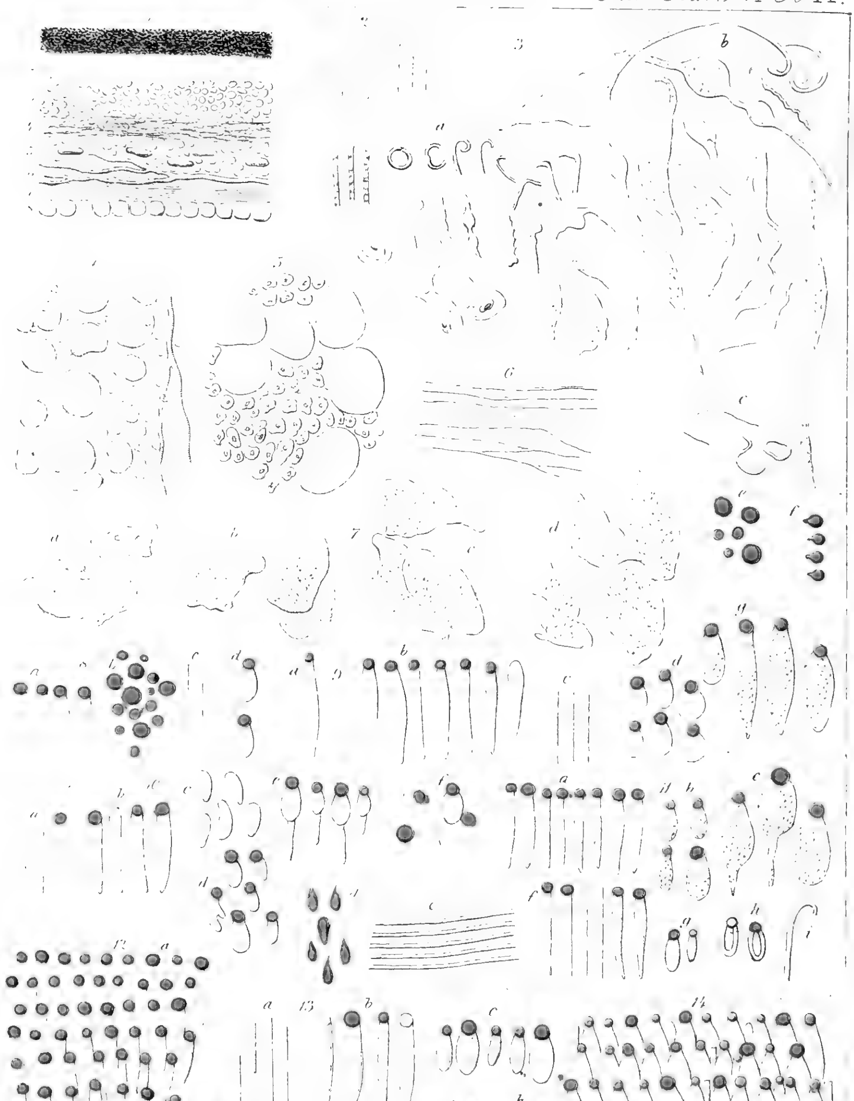

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DESCRIPTION OF PLATES X, XI,

Illustrating Mr. Nunneley's paper on the Structure of the Retina.

PLATE X.

Fig.

1.—Vertical section of human retina, to show the relative position of its elements—(plan of). 1, choroid coat; 2, rods; 3, outer layer of granular cells; 4, indistinct fibrous layer; 5, inner layer of granular cells, in which are imbedded larger vesicular cells, and towards the inner surface is found, 6, the vascular layer, which consists of delicate vessels derived from the larger branches of the central artery of retina, which run on the inner surface of 7, which is the layer formed by the fibres of the optic nerve; 8, transparent cells attaching the retina to the hyaloid membrane.

2.—Human rods, × 450 linear.

3.—Rods in various stages of alteration. *a.* By the addition of water, or after the eye has been in dilute spirit, or a short time after death. *b.* After being treated with dilute chromic acid. *c.* After twenty-four hours' immersion in Goadby's solution. × 450.

4.—Inner surface of posterior portion of human retina, to show the granular layer with larger circular cells amongst which the nerve-fibres run; to the left is seen an artery dividing into two branches. × 450.

5.—Same surface with 1-12 object-glass, and achromatic condenser, × 600, without nerve-fibres, to show the clear transparent cells (probably enlarged by endosmose), and the cellular character of the so-called granular layer, which consists of true cells containing very refractive nuclei.

6.—Nerve-fibres from posterior part of human retina; they appear to bifurcate and to join each other again. × 450.

7.—Irregular flat cells found in the eyes of most, if not all, animals. *a.* From human fœtus. *b.* From pig. *c.* From sheep. *d.* From bullock. All just dead. × 450. Are they caudate gangliform cells?

8.—Turkey. *a.* Conoidal rods surmounted by coloured globules. *b.* Coloured globules of various sizes detached. *c.* Cylindrical rods. *d.* Ovoid bodies with coloured globules. × 450.

9.—Retina of birds. *a.* Conoidal rod with coloured globule from canary bird. *b.* Conoidal rods with coloured globules from various breeds of domestic fowls; in the same bird the size and exact shape varies, perhaps, at least to some extent, depending upon varying pressure against each other. *c.* Cylindrical rods not surmounted by coloured globules. *d.* Ovoid bodies (bulbs, cones) with coloured globules. *e.* Coloured globules seen on outer surface of retina as though with a nucleus, which they do not possess. *f.* Coloured globules seen in

Fig.

profile, showing a small spur, by which possibly they adhere to the conoidal rods, though in the great majority this spur cannot be seen; they appear to be true globules. *g.* Conoidal rods and ovoid bodies become granular.

10.—From duck. *a.* Cylindrical rods, which are larger and more numerous than in the fowl; in one duck all the rods were cylindrical, and many of them were surmounted by the ruby- and canary-coloured globules: there were none conoidal, except such as shewn at *e.* *b.* Conoidal rods from another duck. *c.* Ovoid bodies without coloured globules. *d.* Ovoid bodies with coloured globules. *e.* Ovoid bodies with a conoidal leg attached at the *inner* side; this process becomes detached and breaks up into discs, as do the cylinders, while the more globular portion becomes granular; so that it is difficult to say whether these are ovoid bodies with a portion of rod and globule accidentally attached, or whether the ovoid bodies are not really altered conical rods deprived of the inner process. *f.* Cylindrical rods and ovoid body with coloured globules accidentally attached. × 450.

11.—From swan and goose. *a.* Conoidal rods with coloured globules. *b.* Ovoid bodies with similar globules. *c.* Three of the rods altered. *d.* Coloured globules fusiform in shape. *e.* Strong cylindrical nerve-fibres in retina from swan. *f.* Cylindrical and conoidal rods. *g.* Ovoid bodies. *h.* Rods curled round so as closely to resemble ovoid bodies. *i.* Rod curled into hook at one extremity. × 450.

12.—From Guinea fowl. *a.* Outer surface of retina with rods and globules *in situ.* *b.* Coloured globules detached. × 450.

13.—From green turtle. *a.* Long and short cylindrical rods, neither of which are very numerous. *b.* Conoidal rods, for the most part surmounted by a coloured globule. *c.* Ovoid bodies surmounted by coloured globules. *d.* Very nearly similar bodies without coloured globules. *e.* Ovoid bodies with a short cylindrical leg attached at *inner* side, in two of them it is seen breaking off; they are surmounted by coloured globules. *f.* These different bodies after the lapse of a few hours; immediately on the addition of water; and also from another turtle, which, before being killed, was in a very languid and feeble condition. *g.* Average size of ruby globules. *h.* Of canary globules. *i.* Three of these globules in profile to show spur which some appear to possess, but by far the greater number seem to be true globes; when not exactly in focus, as the globules of birds, they appear to have a nucleus, which, however, they have not. *j.* Nerve-fibres forming a layer in retina. *k.* Finely granular cells. × 450.

14.—Turtle; form, size, and position of elements of outer coat of retina, showing the cylindrical and conoidal rods with the coloured globules, and at their base the ovoid bodies. × 450.

15.—Section of retina of turtle. *a.* Rods. *b.* Coloured globules. *c.* Ovoid bodies. *d.* Granular cells. *e.* Nerve-fibres and blood-vessels. *f.* Transparent cells between last and the hyaloid surface. × 450.

PLATE XI.

Fig.

1.—Portion of back part of retina of bullock seen from the inner surface, to show nerve-fibres and layer of granular cells, which have been partially removed the better to show the fibres forming a layer, with 1-12. × 600.

2.—Fibrous layer of retina, showing varicose enlargements in the nerve-fibres, and also double-walled cerebral cells. × 450. From back part of retina of rabbit. I have seen the same structures in the ox and the sheep, but not quite so distinctly.

3.—Varicose fibres and clear oil-like cerebral cells from optic nerve in the pig, at its entrance into the eyeball.

4.—Layer of cells attaching retina to hyaloid membrane; at first they are perfectly transparent, but soon become very finely granular. They are found in most animals, and are very distinct in the rabbit.

5.—From turtle. There are a few large flat cells with large irregular granular nuclei. × 450. Are they the caudate gangliform cells?

6.—From birds. *a.* Conoidal rods after some hours' immersion in dilute spirit, showing, towards the *inner* end, a conical process with a transverse mark as though breaking off here. *b.* Nerve-fibres from anterior part of retina of Cochin cock; after being forty-eight hours in dilute spirit, they formed a complete layer imbedded in the granular cells; many of the fibres could be traced for a considerable distance, others were much shorter as though terminating at various points, all were more or less varicose; the dilations showing double walls, and with them were some double-walled cells. *c.* Delicate cells, which are during life, or immediately after death become, minutely granular; they are very abundant in all birds. *d.* Perfectly transparent cells, which soon become very large and irregular in size and shape, probably from pressure and overlapping each other; they appear to form a layer between the retina and hyaloid; these are from the canary bird; they are not larger in the goose or turkey than in this little bird. × 450.

7.—Capillary vessels of human retina; the artery from which they are given off measured 1-100 of an inch in diameter; the capillaries not more than 1-4000; washed with dilute liquor potassæ, which, by removing the nerve-structures, renders the congested vessels very distinct.

8.—Terminal vessels in human retina. They form a series of loops a little distance from the ora serrata. *a.* Ciliary processes. *b.* Loops of capillaries joining to form trunk, *c.*

9.—From frog. *a.* Very large cylindrical rods; most, however, are of size seen at *b.* Some of these are rather broader at their inner extremity than at the outer; many, but not all, are surmounted with a light-brown coloured globule, like those of birds and the turtle, but with much less colour; these are shown detached at *c.* They should not be shown with nuclei. *d.* Rods changed by the addition of water; they curl up, become granular, and look like coffee-berries. *e.* Rods after addition of salt and water, which induces much less change than water. *f.* In one frog I found three rods with conical inner ends, and transverse marks as here shown. *g.* A few large cells with pigment-granules, not much unlike some found in the brain, are seen. × 450.

PLATE XI (*continued*).

Fig.

10.—From toad. *a.* Three rods; the majority are not so long as the longest. *b.* Size of pale yellowish globules attached to some of the rods. × 450.

11.—From alligator. *a.* Rods. *b.* Fibrous layer of retina when fresh. *c.* Same layer with granular cells after six hours' immersion in dilute spirit; the nerves have become varicose. × 450.

12.—From chameleon. *a.* Rods. *b.* Granular cells, with which are some larger-brain cells. *c.* Nerve-fibres of retina. × 450.

13.—From golden carp, *Cyprinus auratus*. *a.* Cylindrical rods. *b.* Conoidal bodies, *cones jumeaux*, at first perfectly transparent. *c.* These same bodies, after a short time, or immediately on the addition of water, the lower bulbous portion swells, becomes granular, irregular, splits in the middle, forming the coffee-berry body, breaks up, and disappears, while the surmounting conical leg breaks off, splits into discs, as do the cylindrical rods, and disappears. *d.* Ovoid cells of various sizes, of a dark fuscous colour; they resemble brain-cells. *e.* Nerve-fibres of retina. × 450.

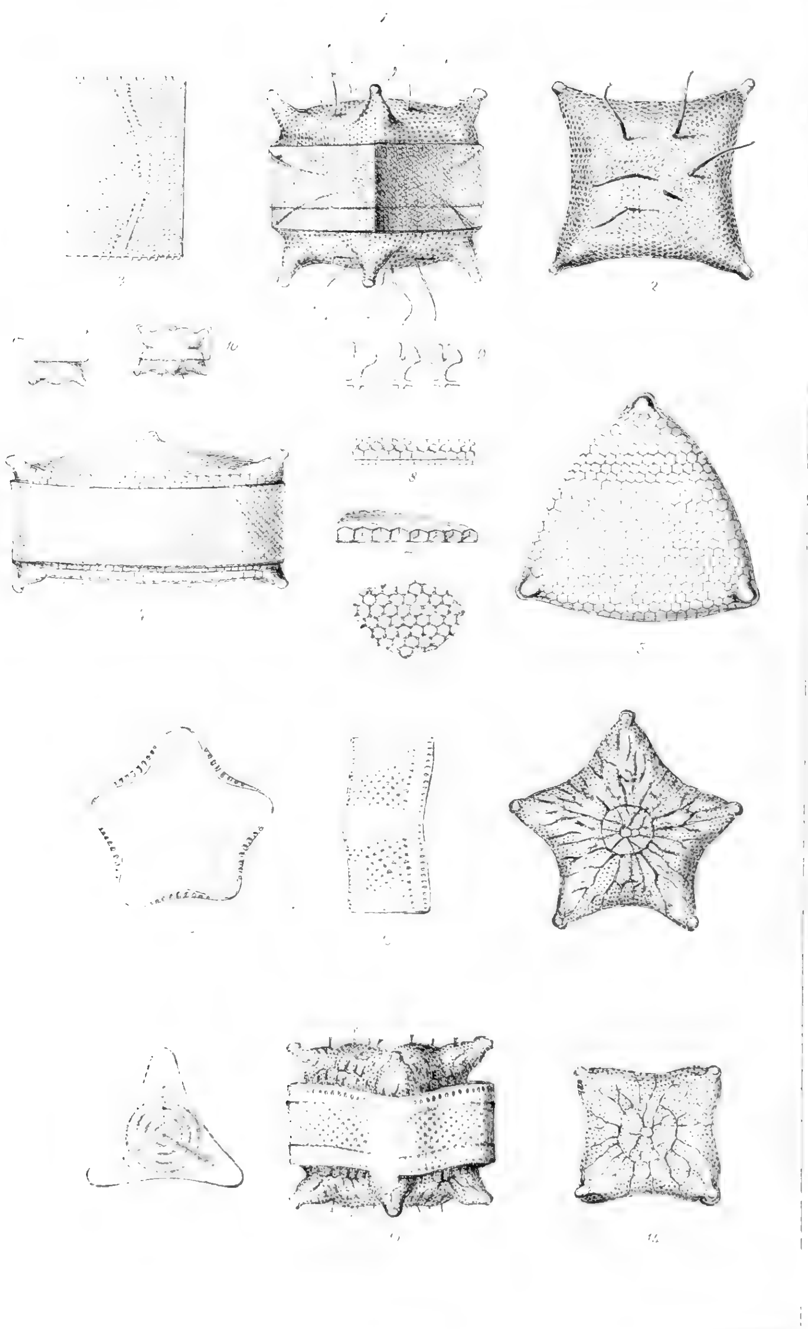
14.—From sand-dab, *Platessa limanda*. In this fish the cones are not numerous, the rods and granular cells are far more so. *a.* Rods. *b.* Conoidal bodies. × 450.

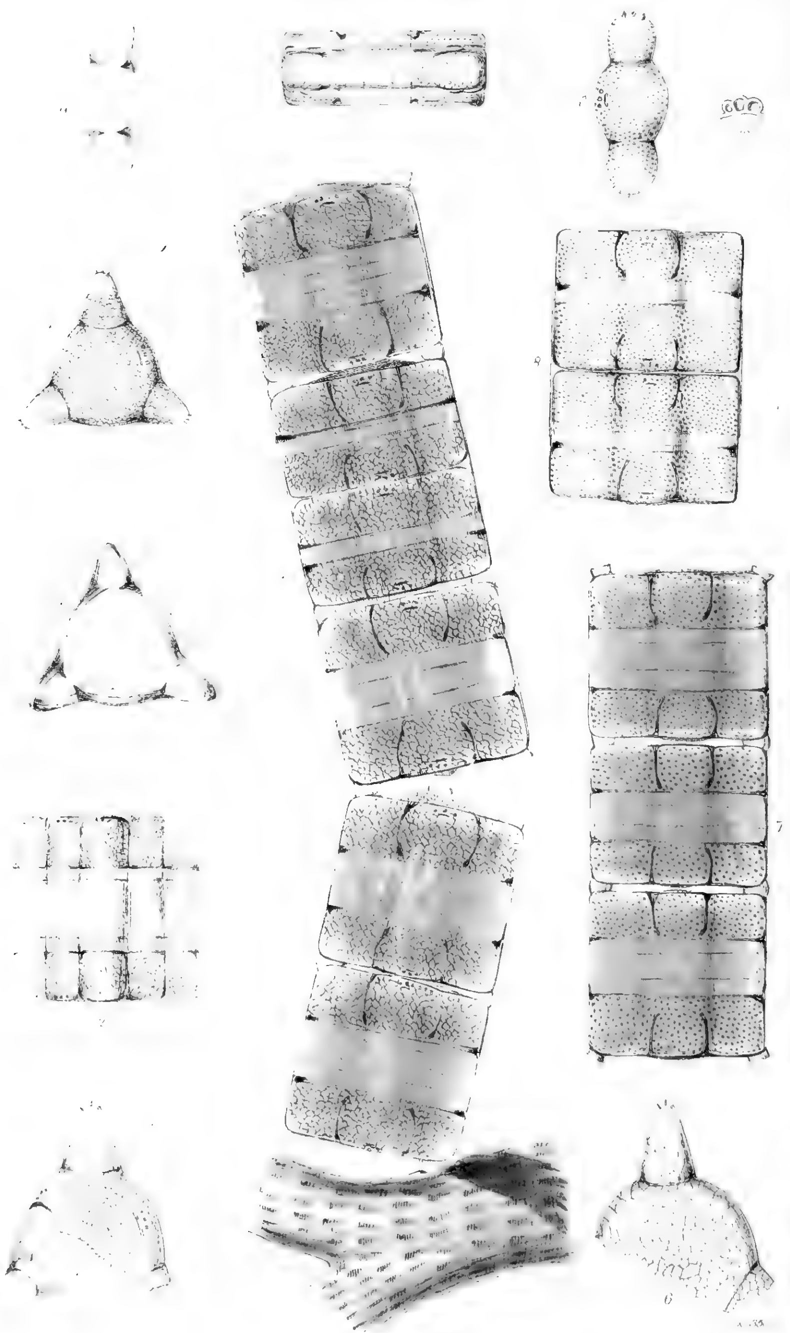
15.—From little weaver, *Trichinus vipera*. In this fish the cones are very distinct, and far more numerous than in the last, but very few have the clear conical leg, and for the most part they lie singly and not in pairs as is common in fish. The rods are neither numerous nor well developed. *a.* Rods. *b.* Cones, which in this and the last fish, if not in life granular, become so before they can be examined. × 450.

16.—From whiting, *Merlangus vulgaris*, which is a good fish for examination, the cones being well developed. *a.* Small rods. *b.* Cones with single bulbs and double conical legs, at first perfectly transparent and homogeneous, but in a very short time immersion in dilute spirit, or instantly on the addition of water, the changes shown at *c* occur, and they disappear in granules. × 450.

17.—From eel. *a.* Rods, which are numerous. *b.* Cones, which are not so numerous. *c.* Brownish red transparent cells, in character not unlike the coloured globules of birds, except that they contain a nucleus. They are not more than half the size of the blood-globules, and they are circular; on the other hand, they are much too large for the pigment-cells of the choroid, which in colour they resemble. *d.* Commencing change in rods or cones, which now (with 1-8) resemble, in size and form, an oatcorn. × 450.

18.—From cod, *Gadus morrhua*, where the retina is very thick and its elements simple. *a.* Normal form and size of cone, the bulb is perfectly transparent and homogeneous; the conical process is single and has two transverse striæ, where it soon breaks. *b.* Cones altered a few hours after death. *c.* A cone seen to alter while under examination, a large granular vesicle formed in the middle, and at each end was a long fibre; these subsequently swelled out, became granular, and disappeared. *d.* Inner surface of retina, some hours after death, showing the large flat nerve-fibres become greatly varicose; they are imbedded in a layer of granular cells, with which are also found many large transparent cells. × 450.





DESCRIPTION OF PLATES XII, XIII,

Illustrating Dr. Wallich's paper on Triceratium and Hydrosera.

PLATE XII.

Fig.

1.—Front view of *Triceratium serratum*.
2.—Valve of ditto.
3.—More highly magnified view of one of the connecting plates during division, showing serrated edge and arcuate band.
4.—*T. fimbriatum*, front view.
5.—Valve of ditto.
6.—Fragment of valve exhibiting cellular structure.
7.—Profile of a fragment, showing depth of cells.
8.—Profile of fimbriæ.
9.—Three of the fimbriæ, seen under a power of 600 diameters.
10.—*T. pentacrinus*, front view.
11.—Valve of ditto.
12.—Connecting membrane of ditto.
13.—Portion of ditto.
14.—*T. pentacrinus*, four-sided variety.
15.—*T. annulatum*.
16, 17.—Two newly separated frustules, showing the supersistent connecting band, formed of the siliceous plates of their halves of the parent frustule; the other or second layer having receded from these, and remained attached to the other newly liberated frustules.

PLATE XIII.

1.—Portion of *Hydrosera triquetra* in natural state.
2.—Frustule of ditto, seen from above, as laid on one of its sides, the central angular ridge only being in focus.
3.—Connecting membrane of same, showing one of the plates forming the annulus, with its imperfect septa. The other plate behind it out of focus.
4.—End view of valve of same, showing cellulation under a power of 250 diameters, the spines at the angles, and processes on one side.
5.—Broken valve, showing one of septa.
6.—Portion of same valve under power of 350 diameters, showing reticulated structure.
7.—Portion of filament of *H. compressa* in natural state.
8.—Frustules of same undergoing division, and exhibiting the lateral appendages.
9.—Connecting membrane of same.
10.—End view of ditto.
11.—Side view of ditto.
12.—Enlarged view of lateral processes.

INDEX TO JOURNAL.

VOLUME VI.

PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE.

INDEX TO TRANSACTIONS.

VOLUME VI.

PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE.

OPINIONS OF THE PRESS—*continued.*

of the Annulata, and thence indirectly to all the lower forms of animal life. Nor has its popularity been limited to one tongue or country; but either through the medium of translations, or by the obvious influence which it has exercised, ever since, over the most esteemed elementary books in other European languages, the influence given has been propagated externally in a widening circle. In noticing this new edition, however, it is with home readers we have to do, and especially with the young, who enjoy a privilege that we of a former generation were debarred from, in being early admitted to fields of instruction and delight, which some time were strictly fenced off from the narrow pen-fold of 'general education.'...... The book is, indeed, a marvel of cheapness, considerably more than 600 closely-printed octavo pages for five shillings...... To our readers, old and young,—parents, children, teachers, respectively,—we say, 'buy and read;' enjoy, verify, and enlarge, by the use of your own eyes and faculties, the curious details in rural economy, animal biography, and mental philosophy, amassed with so much study and personal observation, and digested with equal taste and judgment by the learned authors, indissolubly associated in fame and remembrance, as they were in life-long frendship, though now for a little while separated by a temporal change. To the survivor of the two we owe a very charming addition to the volume, in the shape of letters and recollections connected with the first conception and progress of the work, and the cordial friendship which, having originated and matured the undertaking, so long survived its completion and participated its success." NATURAL HISTORY REVIEW.

"It is almost impossible to read this engaging volume without becoming enamoured of the study of the little creatures whose habits and instincts it describes; and the rapidity with which the new edition is now being sown broadcast over the land, may reasonably be expected to produce before long an abundant crop of incipient Entomologists. But it is not young people merely who are taken captive by this book. We have lately met with two instances in which it has exerted a similar influence over persons in advanced life, and devoted to pursuits which might be supposed little calculated to leave room for any enthusiasm on behalf of insects. In one case a learned friend of ours who had just been exploring, and with good results, the fusty Syriac MSS. of the British Museum, was so delighted with the book, on dipping into a copy which accidentally fell in his way, that he straightway purchased one for himself, read it with avidity, and has since become a most industrious collector. The other instance was that of one of our most popular metropolitan clergymen, who, having had occasion to refer to the book for the elucidation of some passage of Scripture relating to insects, was so deeply interested in what he read that he publicly recommended the work from the pulpit, with a warmth of commendation which somewhat surprised his hearers. The truth is, that to a person who has never before given any attention to the subject, the reading of Kirby and Spence for the first time opens the eyes to a new world of interest and beauty, which appears to be only the more wonderful from the circumstance that it had been so long unheeded."

TITAN, *Nov.* 1857.

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